SBW Consulting, Inc.
Report No. 0303

Achieving Silver LEED™: Preliminary Benefit-Cost Analysis for Two City of Seattle Facilities

FINAL REPORT

Submitted to

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April 2003

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Background

In 2000, the City of Seattle adopted its Sustainable Building Policy requiring new City facilities to attain a Silver LEED™ rating. The LEED™ (Leadership in Energy and Environmental Design) Green Building Rating System was developed by the U.S. Green Building Council (USGBC) to provide standards and means for measuring the life-cycle environmental performance of a building.

The purpose of this study was to evaluate the impacts of the Sustainable Building Policy on two projects nearing completion in early 2003: the Seattle Justice Center and Marion Oliver McCaw Performance Hall. Study objectives include (a) enumerating the costs and benefits of LEED Silver certification, (b) calculating life-cycle benefit-cost ratios for each project within data constraints, and (c) providing early feedback on the effects of the Sustainable Building Policy.

Methodology

Key information for the study came from numerous sources. For information specific to each project, these sources included the city project managers, utilities, and the mechanical design firm. For general information, the USGBC LEED™ reference package, Pacific Northwest commissioning economics studies, and tools based on federal research for quantifying productivity increases were among the sources.

Analysis involved first determining the incremental costs and benefits of actions taken, beyond standard practices and the Seattle Energy Code, to obtain LEED credits. Any actions that were so deemed as baseline were not included in the analysis. Major impacts, such as energy savings and occupant productivity improvements, were quantified using the best available information and calculation approaches. The financial effects of these impacts were calculated for each of the six LEED credit categories for both projects, using City-supplied economic parameters, over a 25-year period. Dividing the net present value benefits by the corresponding costs yielded benefit-cost ratios. These were determined at the credit, project, and overall levels from three perspectives, summarized as follows:

1. General fund perspective - primary costs/benefits to building. The *primary* costs and benefits are those with direct, observable financial impacts, such as the cost of bike racks or lower electric bills.

2. General fund perspective - primary & secondary costs/benefits to building. To the first perspective are added *secondary* costs and benefits, i.e., less easily observed indirect impacts such as increased occupant productivity, that accrue to the building specifically.

3. Citywide perspective - all costs & benefits. To the second perspective are added other *secondary* costs and benefits that accrue to the city as a whole, such as the cost of utility incentives that help pay for conservation measures.

Results

The McCaw Hall and Justice Center projects are expected to receive 40 and 34 LEED points, respectively out of the 69 possible. About 43% of the points could be considered baseline, and would have been obtainable even without additional LEED actions. Some of the major actions that LEED influenced include the west-facing buffer wall, light shelves, and Green roof at the Justice Center, and enhanced construction recycling and indoor air quality management at McCaw Hall. In addition, both projects earmarked significant resources for energy efficiency measures, building commissioning services, and

indoor environment improvements. The most significant incremental benefits that these actions are expected to produce are reduced energy use and improved productivity for building occupants over time.

The overall increase in the initial net cost of the two projects that can be attributed to the influence of LEED certification is $2,637,500. This represents about 1.2% of their combined project budgets. The sustained net benefits are $3,138,400 to $4,542,700 at 6% and 2% discount rates, respectively.

From a General Fund perspective that considers only at primary impacts, the combined benefit-cost ratio is 0.78 to 1.11[1]. From a General Fund perspective that considers all costs and benefits that accrue to the building, the combined BCR is 1.49 to 2.16. Note that the Justice Center BCR is considerably higher than that for McCaw Hall. This mostly reflects the fact that the Justice Center should see large occupant productivity benefits from indoor environmental quality improvements at the building, while McCaw Hall has very few full-time occupants. Even discounting these productivity benefits by half, LEED certification still appears cost-effective at the Justice Center. From a citywide perspective, the BCR for both projects is 1.19 to 1.72, indicating that overall, LEED certification for these two projects has been cost-effective to the City. These results, as well as project-specific breakdowns, can be found in the table below.

	McCaw Hall	Justice Center	Combined
Incremental cost to meet Silver LEED™	$909,400	$1,728,100	$2,637,500
% of project budget	0.7%	1.9%	1.2%
LEED™ points	40	34	
Benefits (over 25 years)	$581,500 - $834,700*	$2,556,900 - $3,708,000*	$3,138,400- $4,542,700*
Benefit-cost ratios			
1. General fund perspective - primary costs & benefits to building (i)	0.79 - 1.14	0.77 - 1.10	0.78 - 1.11
2. General fund perspective - primary & secondary costs & benefits to building (ii)	0.74 - 1.07	1.93 - 2.80	1.49 - 2.16
3. Citywide perspective - all costs & benefits (iii)	0.64 - 0.92	1.48 - 2.15	1.19 - 1.72

*The range represents two different discount rates, 2% and 6%

(i) Primary = direct, observable financial impacts, e.g., costs of bike racks, lower electric bills.

(ii) Secondary = indirect costs and benefits, e.g., productivity benefits.

(iii) Also includes the portion of conservation measures paid for through municipal utility incentives.

Conclusions

Analysis results indicate that for the two projects studied, their combined actions spurred by the Sustainable Building Policy's LEED Silver certification requirement yielded significant energy efficiency and occupant productivity benefits. Overall, these benefits offset the costs sufficiently to make the LEED actions cost-effective, both from a General Fund and citywide perspective. The cost-effectiveness is marginal for McCaw Hall, largely because of the very low expected occupancy rate. Low occupancy reduces the benefits of efficient energy use and improved indoor environmental quality, the two areas where LEED had the largest impact. Any future strategy City to maximize the economic benefits

[1] A BCR greater than one indicates that LEED-influenced actions were cost-effective overall.

obtained from LEED certification expenditures should take into account building occupancy and usage patterns, and allocate funds accordingly.

The evaluation also found that City projects could benefit from a standardized process early during the project design for selecting the most suitable LEED credits. Performing preliminary credit-by-credit benefit-cost analyses can help ensure that the maximum number of credit points necessary for LEED silver certification is obtained at the minimum incremental cost. Also, it may be worthwhile for the City to document the rationale behind selecting particular credits for each project, as well as the expected and actual costs and benefits. This information could help future building projects obtain LEED certification most efficiently and cost-effectively.

Because the Seattle area has particularly strict codes and regulations intended to protect the environment, many of the LEED actions that the two projects studied took were considered baseline, with no initial net costs or sustained net benefits. In other areas of the country with less stringent requirements, these same actions on other projects would have net costs and benefits that could alter their BCRs. Therefore, care must be taken in applying these results to projects outside of Seattle.

Several factors influenced the uncertainty in this study. Data collection and analysis took place while both projects were still under construction, so some important information was not yet fully available. In addition, many of the major benefits from LEED actions, such as energy savings and productivity increases, are based on assumptions about commissioning, measurement and verification, and future building occupancy and operation that can only be approximated in advance. Follow-up evaluations can refine the benefit and cost estimates for the two projects by using new data from additional sources to revise and improve the analysis.

1 Introduction

1.1 Background

In early 2000, the City of Seattle adopted its Sustainable Building Policy, which directed City departments to design and construct new and renovated City facilities greater than 5,000 square feet so that they achieved a Silver LEED rating. Seattle was the first municipality in the country to set such a goal for its own facilities. The City's Office of Sustainability and Environment (SOSE) is responsible for overseeing implementation of this policy.

The U.S. Green Building Council (USGBC) developed LEED™ (Leadership in Energy and Environmental Design) Green Building Rating System in the 1990s. It is a means to evaluate the environmental performance of facilities from a whole building perspective over a building's life cycle, and to provide a definitive standard for how "green" a building is. Buildings can become certified at four increasingly challenging levels, based on how many credits the building earns[2]. Projects can obtain credits in six categories: (1) Sustainable Sites, (2) Water Efficiency, (3) Energy & Atmosphere, (4) Indoor Environmental Quality, (5) Materials & Resources, and (6) Innovation & Design Process.

As of the summer of 2002, the City had at least 13 projects underway that are working towards obtaining a Silver LEED rating[3].

1.2 Study Objectives

The purpose of this study is to evaluate the impacts of the Sustainable Building Policy on two projects: (1) Seattle Justice Center (referred to as the "Justice Center" for the remainder of the report) and (2) Marion Oliver McCaw Performance Hall ("McCaw Hall"). These two projects are among those that are nearest completion, although both were still under construction as of the end of 2002. Because of this, no LEED certification documentation yet exists, so the results of this study are preliminary. Specific objectives of this study are to:

(1) Enumerate the benefits and costs of LEED Silver certification. These may include the following areas:
   - Utility costs savings (water, sewer, electricity, gas, stormwater (drainage), solid waste)
   - Human factors (occupant health, productivity, worker/visitor satisfaction)
   - Building management (churn rates, internal relocation costs)
   - Building O&M
   - Public goodwill
   - Greenhouse gas emissions
   - Water quality

(2) Quantify the costs and benefits (beyond current city practices) associated with LEED Silver certification as precisely as possible, given the limited data currently available and study budget constraints. Based on these quantities, calculate life cycle benefit-cost ratios for each project from the perspective of the City's general fund and the City overall.

[2] "Silver" is the third highest level, after Platinum and Gold, but before Bronze.
[3] These ratings will be based on the criteria established in LEED Version 2.0, which was released in March 2000.

(3) Provide early feedback to the City Council on the effects of the Sustainable Building Policy, as well as guidance for possible revisions to it. Also, provide information to the USGBC, other public jurisdictions, and other businesses about the costs and benefits of sustainable building practices.

A future study will revisit these objectives after the facilities have been occupied for some period and the LEED certification application has been completed. It will then revise the analysis results as appropriate. Note that this study specifically does not intend to evaluate whether these projects actually qualify for certain LEED credits and overall Silver certification. The USGBC will ultimately be responsible for this task.

1.3 Report Overview

The report is organized as follows:

Chapter 2: describes the methodology for data collection and analysis.

Chapter 3: discusses LEED credits applicable to these projects, including the intent of each credit, actions taken to obtain them, and the costs and benefits associated with these actions.

Chapter 4: presents the results of the benefit-cost analyses for each building and overall.

Chapter 5: provides conclusions based on the analysis results.

Chapter 6 (Appendix): contains credit-by-credit descriptions of actions taken and their impacts, detailed calculation summary sheets for each LEED credit category for each project, and overall analysis summary sheets for each project.

1.4 Acknowledgements

This study would not have been possible with the generous assistance of many others. Critical to this effort were Jun Quan with City of Seattle Fleets and Facilities Department and Stephanie Van Dyke with Seattle Center. They are the project managers for the Justice Center and McCaw Performance Hall projects. The two of them, along with designers and contractors on their project teams, provided a wealth of information about the details of the LEED certification process for these facilities. Tom Paladino of Paladino & Company supplied important information about quantifying productivity benefits associated with LEED credits. Kim Drury and Lucia Athens with the Seattle Office of Sustainability and Environment were responsible not only for overseeing this analysis effort, but also providing guidance and inputs for it.

2 Methodology

2.1 Definitions of Terms Used in this Analysis

This analysis relies on a large number of terms to classify costs and benefits. Understanding these terms is crucial to understanding the methodology, so key terms are defined below.

Baseline	The applicable regulations or industry standard practices in the city of Seattle that would dictate what actions would be done in the absence of LEED certification. Codes, regulations, and standard practices in the Seattle area, as a rule, are more stringent regarding resource efficiency and environmental impacts than in many other parts of the country. Whether this fact makes LEED certification in Seattle more or less cost-effective is a complex question. Lower baseline standards can result in LEED producing more incremental benefits, but they can also create higher incremental costs. This analysis adopted as a general baseline the minimum standard practices common in Seattle-area public buildings. Any action that exceeded this baseline could result in incremental costs and/or benefits that we credited to LEED. Specific facilities in Seattle may have standard practices that well exceed the standard practices in the Seattle area. An example is the Seattle Center, where electronic irrigation controls have been in common use for many years. The baseline chosen for this analysis still credits the Seattle Center with water savings from the LEED credit associated with irrigation controls, even though the Center most likely would have installed these controls without LEED. Doing so avoids penalizing the Center for better-than-average practices.
Impacts	Generic term that encompasses both costs and benefits.
Initial / sustained	*Initial* impacts accrue during the building design, construction, and start-up process. Examples include the cost of hiring a commissioning agent, or solid waste disposal savings resulting from increased construction waste recycling. Since most initial impacts resulted in increased project costs, we referred to the initial impacts collectively as *initial net costs*. *Sustained* impacts are ongoing expenses, cost reductions, or added value that persist for an extended period after construction is complete and the building is occupied. Examples include electricity savings from LEED-related energy efficiency measures, and improved indoor air quality. Because most sustained impacts resulted in savings to the building, we referred to sustained impacts collectively as *sustained net benefits*.
Quantified / non-quantified	*Quantified* impacts are those addressed in this analysis. In nearly all instances where such impacts were deemed significant (with the potential to materially affect the benefit-cost ratio for the project) to the city of Seattle or the specific buildings, we quantified the impact as well as the data and budget available permitted. One exception is the value of the public relations that the city of Seattle receives for its participation in the LEED program. *Non-quantified* impacts were those that had regional, national, or global impacts, and for which it is nearly impossible to quantify financial effects. In general, our opinion was that if such impacts were to be quantified somehow, their net impact on the city of Seattle

	or the project/building would be relatively small. Examples include reduced ozone depletion and improved wildlife habitat.
Primary / secondary	*Primary* impacts generally result in an easily observable financial effect to the project/building. These can be either initial impacts, such as the incremental cost of installing bicycle racks, or sustained impacts, such as decreased utility bills or building maintenance savings. *Secondary* impacts affect the city of Seattle financially, but most likely only have an indirect financial effect on the project/building. For initial impacts, this would include the cost of utility incentives. For sustained impacts, this could include the financial benefit of higher occupant productivity from improved indoor air quality
Building-level / city-level	*Building-level* impacts affect building construction costs, or affect building occupants or O&M staff by lowering utility bills or improving air quality. These impacts could be said to have the "perspective of the General Fund." *City-level* impacts have a broader effect than building-level ones, and affect the city of Seattle overall. An example might be Seattle City Light incentives, which reduce the building-level cost, but ultimately must be paid by utility ratepayers throughout Seattle.

2.2 Overview

Major steps in the analysis included the following:

1. Compile available documents and information sources (these sources are described in more detail in Section 2.3).
2. Determine applicable LEED credits.
3. Develop a list of costs and benefits associated with each credit.
4. Interview project managers to determine specific actions taken to obtain LEED credits. Establish whether these actions could be considered baseline. Obtain any cost and savings information available for actions beyond baseline.
5. Develop approach for quantifying significant impacts. Obtain additional information to the extent available.
6. Review approach developed by Paladino & Company for estimating productivity increases associated with LEED credits. Adapt this approach to this analysis.
7. Calculate impacts and incorporate in a life-cycle cost analysis framework (described in more detail in Section 2.4).
8. Write a summary report documenting the methodology and results.

2.3 Data Sources

The analysis relied on seven key data sources. These sources, as well as the manner in which they were used, are described below.

A. LEED Reference Package: The Version 2.0 package, issued in June 2001, provided general info about the intent of each LEED credit, along with potential costs and benefits associated with them. This package also contains a comprehensive checklist for tabulating potential LEED certification credits, which was used as a starting point for the analysis.

B. City project managers: Through numerous meetings, phone calls, e-mails, and mailings, they provided detailed information about (1) which LEED credits the projects were attempting to obtain, (2) actions taken to obtain these credits, (3) whether actions could be considered standard practice, (4) costs and savings, when available, associated with actions beyond baseline, and (5) the decision-making process underlying LEED-related choices. These project managers also consulted with other project team members to get information.

C. Utilities: Websites and personnel from Seattle City Light (electricity), Seattle Public Utilities (water/sewer/stormwater), and Puget Sound Energy (natural gas) provided information about appropriate billing rates, avoided cost assumptions, conservation program incentives, and baseline usage and potential savings for certain water measures.

D. Paladino & Company, Inc.: Supplied the *City of Seattle LEED Evaluation Plan* they prepared for SOSE in 2002. This plan details a methodology for and results from estimating productivity benefits from improved indoor environmental quality for a number of City facilities, including the two projects in this study. This approach estimates payroll costs for each building, then uses U.S. Department of Labor Bureau of Labor Statistics information to estimate lost productivity from thermal discomfort, illness, and respiratory distress. Subsequent reductions from lost productivity are quantified using results developed from a review of a broad range of indoor environmental research by William Fisk et al at the Lawrence Berkeley National Laboratory, as reported in the Year 2000 Annual Review of *Energy and Environment* and other places.

   The approach developed by Paladino in turn links these reductions to the number of applicable LEED credits that the particular building is seeking. Our analysis took this a step further by limiting the credited productivity increases only to those credits that resulted in actions beyond baseline. Also, because there is a great deal of uncertainty about how to apply the Fisk results to LEED situations, our analysis prorated the benefits by 50% to be conservative. This also reflects the fact there can be a downside to impacts of LEED measures, e.g., daylighting can both improve comfort for some, but lead to glare complaints for others. It is important to note as well that our analysis only quantified benefits to full-time occupants of the buildings, not the public at large.

E. Mechanical design firm: The mechanical designer for both projects was CDi Engineers. This firm prepared detailed studies of potential energy efficiency measures at each, based on PowerDOE hourly simulation models using the 1997 Seattle Energy Code as a baseline. We reviewed the key assumptions and results in these studies, and revised them as necessary based on our engineering judgment, as well as the opinion of Seattle City Light staff involved with the analyses.

F. Northwest Energy Efficiency Alliance commissioning studies: To estimate the potential energy impacts of commissioning, we drew upon results of a study of the costs and benefits of commissioning in public buildings that SBW Consulting, Inc. is performing for the Northwest Energy Efficiency Alliance (NEEA). This study has quantified energy impacts for 20 projects to date, and the results are to be published in the proceedings of the *2003 National Building Commissioning Conference.*

G. Seattle Office of Sustainability & Environment (SOSE): SOSE analysts provided estimates of the impact that various LEED actions, most notably energy savings and increased construction waste recycling, would have on greenhouse gas (GHG) emissions. Referenced data sources included the *Revised 1996 Guidelines for National Greenhouse Gas Inventories* by Houghton et al, and two publications released by the Environmental Protection Agency (EPA). The latter were *The WARM Reduction Model for Solid Waste Management* and *Greenhouse Gas Emission Factors for Management of Selected Materials in Municipal Solid Waste*. The analysis presumed that changes in GHG emissions would affect the number of GHG offsets that the City of Seattle would need to obtain.

2.4 Analysis

This discussion of our analysis approach first lays out key economic assumptions, then provides a step-by-step description of how we calculated LEED impacts. The final section explains how we treated major issues that affected the overall analysis framework, such as utility influence and building performance degradation.

2.4.1 Key Economic Assumptions

The SOSE established the following guidelines for conducting life-cycle benefit cost analysis:

i. 25-year life cycle

ii. Perspective of the City's general fund

iii. Escalation of water and sewer rates by 1.5% per year above inflation.

iv. Electricity rates that decline by 6% in nominal terms until 2005, then escalate by 1% per year in nominal terms until 2021.

v. Two scenarios for discount rates: 2% and 6% (real).

We assumed a general inflation rate of 2.8%, consistent with official U.S. government figures for 2001. For assumptions about current utility rates, escalation rates, and avoided costs, we contacted utility and government sources for the best available information. The final assumptions used in the analysis are as follows:

- Electricity: Current rate of $0.0586/kWh, per Seattle City Light Medium Standard General Service rate. Escalated as described above.

- Electric demand: Current rate of $1.03/kW/month, with same source and escalation as Electricity.

- Natural gas: Current rate of $0.55338/therm, per Puget Sound Energy Schedule 31 rate. Real escalation rate of 0.3% from USDOE FEMP sources. Avoided utility costs for natural gas not applicable to this analysis.

- Water: Per Seattle Public Utilities, current rates of $1.69/CCF and $2.75/CCF during off-peak and peak seasons, respectively. One CCF equals 748 gallons. Escalated as described above.

- Sewer: Per Seattle Public Utilities, current rate of $5.12/CCF, escalated as described above.

Additional details of all rates and other assumptions described above can be found in the appendix. We also considered, but did not include, two other economic effects in our analysis. For the first, the study assumed that the value of conservation programs, i.e., utility avoided costs, is already taken into account when the utilities set billing and program incentive rates. Secondly, the incremental first costs of LEED presumably increased the amount of borrowing needed to finance these two projects, resulting in additional costs over time to service the debt. These latter costs are not included in this analysis.

2.4.2 General Analysis Approach

For both of the projects, we followed the approach described below to quantify the costs and benefits resulting from LEED certification:

1. For each LEED credit or prerequisite that the project manager indicated they were likely to obtain, we obtained as much information as possible about:
    - Specific actions taken on the project to obtain the credit or prerequisite.
    - The baseline activities that would have taken place in the absence of LEED certification.
    - The incremental benefits from the action(s).
    - The incremental costs from the action(s).

    Details of the findings for each credit can be found in the appendix.

2. For all quantified impacts, we drew extensively from the main data sources described in Section 2.3 to estimate their initial, sustained, primary, and secondary costs and benefits. As necessary, we augmented our analysis with other sources, such as engineering judgment from results for similar projects, cost estimating guides, and information from utility conservation experts. Because both projects in the study are still under construction, most of the costs and nearly all of the benefits are projections based on the best available information.

3. Individual impacts were aggregated for each of six LEED credit categories (such as "Sustainable Sites", and "Innovation and Design") and input into a standardized economic modeling spreadsheet. The inputs to this spreadsheet were primary and secondary net initial costs and first-year impacts (e.g., kWh/year, CCF/year, or $/year). The spreadsheet applied the economic parameters listed in Section 2.4.1 to calculate primary and secondary benefits in terms of net present value dollars over the study life at discount rates of 2% and 6%.

4. Net-present-value costs and benefits for the six LEED credit categories were tabulated in an analysis summary spreadsheet, which calculated overall costs and benefits at the primary/secondary and building/city levels for each credit category, as well as overall. We also calculated benefit-cost ratios for three scenarios: (a) primary impacts only, (b) building-level impacts only, and (c) all impacts. Overall costs included the relatively nominal cost of LEED registration, certification, and application preparation. This latter cost is apportioned evenly among the six credit categories.

2.4.3 Baseline and Long-Term Impact Assumptions

During the course of the analysis, we encountered a number of critical assumptions regarding the appropriate baseline to assume, as well as the expected long-term effects of certain LEED-influenced actions. These assumptions, in most cases, significantly affected the benefit-cost ratios for the projects we analyzed. How we treated these assumptions, and the basis for doing so, are documented below.

2.4.3.1 Utility Program Influence

The electric, gas, and water/sewer utilities for the two analyzed projects offer substantial financial incentives to their commercial customers for implementing efficiency measures. Understanding the role these incentives played in influencing the projects to install the measures they did is critical to properly assessing the benefit-cost ratio. Electricity-saving measures in particular make up a significant percentage of the incremental costs and benefits for both projects. If the projects would have implemented these measures anyway, in large part because of the generous utility incentives available, then the costs and benefits from electricity conservation would have to be considered baseline, and eliminated from this analysis.

Conversations with SOSE staff and project managers for the buildings, however, indicated that the Justice Center project in all likelihood would not have pursued utility incentives had it not been for LEED certification, and that this could be considered standard practice in city facilities. The Seattle Center as a rule does pursue utility incentives for their projects, but this exceeds city standard practice. We assumed the latter for the baseline, which establishes for this analysis that the utility programs did not influence project activities, and that their only impact was to shift some of the overall cost of the efficiency measures from the project to the City at large (i.e., from primary to secondary initial net costs).

2.4.3.2 Multiple Influences on Actions

The Justice Center project is an aesthetically and architecturally striking structure, with several innovative features that are linked to LEED certification. These include the (1) thermal buffer wall, a clear wall with two widely-separated glazing layers that maximizes views and daylighting while providing acceptable comfort and energy efficiency, (2) light shelves near the buffer wall that are an integral part of the building daylighting strategy, and (3) a large central staircase to facilitate occupant circulation that will reduce elevator use somewhat. Since all three of these features resulted in significant first costs, we needed to be particularly careful to determine what portions, if any, of these costs should be attributed to LEED certification. The decisions to include these features in the building design were complex ones, driven by many factors on the project.

For this reason, we engaged in extensive discussions with the Justice Center project manager to understand the decision-making process underlying these three features. It became clear that the central staircase would have been installed in its current configuration regardless of LEED, whereas LEED did have a significant influence on the buffer wall and light shelves. Some form of buffer wall design most likely would have happened in the absence of LEED, but LEED advanced the design to integrate a totally transparent wall with substantial daylighting of the interior space. Similarly, the decision to include the light shelves to improve daylighting performance was driven primarily by LEED certification.

Based on this information, our analysis eliminated the cost and benefits of the central staircase from consideration. The cost of the thermal buffer and light shelves were prorated by 50% and 25%, respectively, to account for the fact that other considerations aside from LEED led to their inclusion in the project. These percentages reflect our best estimates of the relative impact of LEED on these features, in the absence of a more rigorous surveying methodology that could more precisely quantify the relative impact. Because of the methodology by which the productivity benefits associated with thermal buffer and light shelves were quantified, we did not correspondingly prorate the benefits. The benefit calculation algorithm used relies on a binary input to assign benefits—in other words, if a certain credit exceeds baseline, then the full benefits are assumed to accrue. This methodology might benefit from future enhancements to include some kind of proration mechanism, but making such changes fell beyond the scope of this study.

2.4.3.3 LEED Learning Curve

On the McCaw Hall project, construction contractors requested additional funds to comply with the LEED requirements for construction indoor air quality management during construction (Credit EQ-3.1) and construction waste recycling (Credit ID-3.1). According to the contractors, this money was necessary to provide additional staffing, coordination, and resources that it was assumed LEED would require. According to the Seattle Center project manager, the contractors may have increased their funding requests significantly to account for contingencies and uncertainties in the process, since they were unfamiliar with the LEED requirements. Thus, it is likely that on future projects, the contractors will have learned how to meet LEED requirements more efficiently. Our analysis does not adjust for this "learning curve" effect, in which higher costs for this project may result in lower costs for future projects.

2.4.3.4 Measure Degradation

Past research on building system performance has shown that the savings associated with certain resource conservation measures can degrade over time without periodic maintenance and adjustment. As a simple example, an HVAC programmable thermostat may, over the years, develop improper setpoints and on/off times. Facilities staff would need to occasionally check the thermostat settings to ensure that they are appropriate, and to verify that thermostat is still controlling the HVAC unit properly. Some of these activities could be considered "continuous commissioning," which is discussed in the next section.

The energy and water/sewer savings associated with LEED actions in this analysis are estimates for the first year of operation. How these savings decrease over the life of the building depends on many factors, including the level of operations and maintenance attention paid to the equipment and controls. One can assume at the extremes that first-year savings will continue for the entire life of the building, with an incremental operations and maintenance cost incurred at periodic intervals, or that the savings will degrade by some unknown percentage in the absence of additional O&M investment. Both the future O&M cost and the potential savings degradation are extremely difficult to quantify, but they have major impacts on the LEED benefit-cost analysis. Since O&M costs are somewhat less difficult to estimate, our analysis assumed that both buildings incurred a nominal annual O&M increase to sustain all measure savings at 100%.

2.4.3.5 M&V and Continuous Commissioning

LEED certification provides clear-cut guidance on up-front actions that can result in energy or water savings. The LEED guidelines also provide a credit (EA-5) for performing the activities necessary to verify that the predicted savings are actually being achieved once the building is operational. This so-called savings measurement and verification (M&V) is a one-time event that occurs after the building is commissioned and at steady state occupancy. It involves installing metering and collecting data to calculate the actual savings achieved by the water and energy efficiency measures that were implemented under the Water Efficiency and Energy/Atmosphere credits. If a project does not attempt to obtain any water or energy efficiency credits, then the M&V credit is not relevant. M&V activities only apply to those portions of the energy and water systems that are affected by the efficiency measures.

What is somewhat less clear, however, are the provisions LEED recommends for ensuring that (a) the verified resource savings are maintained, and (b) all building systems are functioning optimally, over the life of the building. Such a systematic approach to periodically "tuning up" building systems is generally referred to as "continuous commissioning." While the LEED reference manual discusses the benefits of doing this, the activities required by the M&V credit (EA-5) do not necessary lead to continuous commissioning. As was discussed in the previous section, a sustained investment of time and resources by facilities staff at each building are necessary to ensure good building performance. A comprehensive

continuous commissioning effort would not only make sure that equipment related to efficiency measures is functioning properly, but could also uncover problems in other unrelated equipment that could improve overall energy/water efficiency.

Our analysis assumed that both buildings would be willing to incur a small annual expense to ensure that energy and water conservation measures are functioning properly. It is possible that they would be willing to do more, and commit to full-fledged continuous commissioning of all building systems, but this analysis does not assume so.

3 LEED Credits

3.1 Expected Credits

Both the Justice Center and McCaw Hall projects are attempting to obtain LEED Silver certification, which requires between 33 and 39 points, out of a total of 69 possible points. At present, the projects are expecting to claim 34 and 40 credits, respectively. Typically, projects will attempt to obtain more credits than necessary in case the U.S. Green Building Council rejects some of them. Table 3.1 below breaks down the expected points for each project by LEED credit category. The baseline column indicates the number of credits that will be received for actions that can be considered standard practice in Seattle public buildings. Some of the areas these "baseline" credits dealt with included siting and alternative transportation, regional materials, low-emitting materials, indoor chemical/pollution source control, and construction waste management.

Note that the LEED rating system also has "Prerequisites," which are required actions that do not yield LEED credits, but are necessary for certification. Our analysis considers the costs and benefits associated with prerequisites, where they exceed baseline practices. More details of the actions associated with individual credits and prerequisites can be found in Section 6.1 of the Appendix.

Table 3-1: Expected LEED Credits – Counts of All and Those Considered Baseline

	McCaw Hall			Justice Center			Combined		
Credit Category	Total credits expected*	# expected credits that are baseline	Baseline as % of total	Total credits expected*	# expected credits that are baseline	Baseline as % of total	Total credits expected*	# expected credits that are baseline	Baseline as % of total
Sustainable Sites	8	5	63%	10	6	60%	18	11	61%
Water Efficiency	2	1	50%	2	1	50%	4	2	50%
Energy & Atmosphere	6	0	0%	6	0	0%	12	0	0%
Materials & Resources	5	4	80%	2	2	100%	7	6	86%
Indoor Environmental Quality	14	4	29%	12	7	58%	26	11	42%
Innovation & Design Process	5	1	20%	2	1	50%	7	2	29%
TOTAL	**40**	**15**	**38%**	**34**	**17**	**50%**	**74**	**32**	**43%**

* 33 credits are required for LEED Silver certification. 69 credits is the maximum possible.

Table 3-1 clearly indicates that these projects could have obtained a significant percentage of necessary credits (43% on average) without taking any additional action beyond standard practice, aside from completing the LEED application. The Sustainable Site and Materials & Resources categories in particular have high baseline percentages. Conversely, none of the Energy & Atmosphere credits could be considered baseline.

The sections below describe in more detail the goals of each LEED credit category, the actions that exceeded baseline, and the ramifications of these actions. For each of the six credit categories, an associated table lists the applicable credits, the LEED intent, specific actions taken, and the associated costs and benefits. Note that in some cases, costs and benefits from a particular action may apply to two or more credit categories.

3.2 Sustainable Sites

The Sustainable Sites credit category contains 14 possible points and one prerequisite. Credits in this category focus on selecting building sites that minimize adverse environmental impacts, encouraging alternative transportation, reducing site disturbance during construction, and minimizing thermal and light pollution. Major actions beyond baseline that the Justice Center and McCaw Hall projects undertook to obtain some of these credits include:

- Installing bike racks, electric charging stations, and natural gas fueling stations.
- Adding a Green Roof--plants and grasses growing in soil atop a membrane roof (see Section 3.3 Water Efficiency as well).
- Installing a rainwater collection system to provide irrigation water.

These actions all increased design and construction costs for the project, and the study quantified this cost. Maintenance costs may also increase by a small amount, considered negligible for this study. The only associated benefit we quantified was potentially reduced utility stormwater charges. In addition, these actions may yield other minor, less tangible benefits. Table 3-2 provides additional details of these benefits, plus all credit impacts.

Table 3-2: Impacts from Sustainable Sites Credits

LEED Credit	Credit intent	Actions taken*	Costs**	Benefits**
4.2 Bicycle storage & changing rooms	Reduce pollution & land development impacts from automobile use	Added bike racks (M).	• Rack installation. • Loss of space for other uses.	• Reduced auto use. • Health benefits for cyclists. • Improved community interaction.
4.3 Alternative fuel refueling stations		Installed electric charging (M, J) and natural gas fueling (J) stations.	• Charging/fueling station installation. • Station maintenance.	• Reduced air pollution. • Reduced depletion of petroleum supplies.
5.1 Protect or restore open space	Conserve existing natural areas and restore damaged areas to provide habitat	Installed Green Roof (J).	• Green Roof design & installation. • Increased roof maintenance.	• Additional plant and animal habitat. • Improved air quality. • Improved occupant working conditions.
6.1 Stormwater management – rate/quantity	Limit disruption of natural water flows by minimizing stormwater runoff	Installed Green Roof, rainwater collection system (J).	• Green Roof design & installation. • Rainwater system installation. • Roof, system maintenance.	• Reduced stormwater peak flows, combined sewer overflows.
7.2 Landscape/ exterior design to reduce heat islands (roof)	Reduce heat islands to minimize habitat and microclimate impact	Installed Green Roof (J), EnergyStar roof (M, J).	• Green Roof design & installation. • Increased glare for other building occupants.	• Reduced building cooling loads. • Extended roof membrane life.

* M = Marion Oliver McCaw Performance Hall, J = Seattle Justice Center.
** Shaded costs and benefits have been quantified for this analysis.

3.3 Water Efficiency

The Water Efficiency credit category contains five possible points and no prerequisites. Credits in this category focus on reducing water use inside the building, reducing exterior water use for landscaping, and improving wastewater treatment. Major actions beyond baseline that the Justice Center and McCaw Hall projects undertook to obtain some of these credits include:

- Adding irrigation controllers to regulate watering of landscaping.
- Installing Green Roof (see Section 3.2 Sustainable Sites as well) and plaza landscaping with a rainwater collection system to provide irrigation water.
- Installing waterless urinals.

The first two actions increased design and construction costs for the project, but the waterless urinals at McCaw Hall actually reduced plumbing costs. All of the actions will reduce utility water and sewer charges, and the waterless urinals may reduce maintenance costs by a small amount. Table 3-3 provides additional details of all credit impacts.

Table 3-3: Impacts from Water Efficiency Credits

LEED Credit	Credit intent	Actions taken*	Costs**	Benefits**
1.1 & 1.2 Water-efficient landscaping	Limit or eliminate potable water use for landscape irrigation.	Installed Green Roof, rainwater collection system (J). Added irrigation controllers (M).	• Green Roof design & installation. • Irrigation controller installation (partially offset by utility rebates). • Increased roof maintenance.	• Reduced utility water charges. • Reduced water use during peak demand periods.
3.1 Water use reduction (20%)	Maximize water efficiency within buildings to reduce burden on municipal water/sewer systems.	Installed waterless urinals (M).	• Increased material cost for waterless urinals (partially offset by utility rebates).	• Reduced utility water/sewer charges. • Reduced plumbing costs. • Net reduction in urinal maintenance costs (e.g., no flush valve repair costs).

* M = Marion Oliver McCaw Performance Hall, J = Seattle Justice Center.
** Shaded costs and benefits have been quantified for this analysis.

3.4 Energy and Atmosphere

The Energy and Atmosphere credit category contains 17 possible points and three prerequisites. Credits in this category focus on optimizing building energy efficiency through measures, commissioning, and savings verification. They also seek to minimize adverse environmental impacts from ozone depletion and power generation. Major actions beyond baseline that the Justice Center and McCaw Hall projects undertook to obtain some of these credits include:

- Researching, designing, and implementing various energy efficiency measures (EEMs) that affected cooling systems, lighting fixtures and controls, HVAC distribution/heat rejection systems and controls, and the building envelope.

- Hiring commissioning agents to perform design- and construction-phase commissioning, as well as develop and implement measurement and verification plans.

These actions significantly increased design and construction costs for the project. In addition, Credit 5 (M&V) potentially could result in increased building O&M costs on an ongoing basis. However, the associated benefits—particularly reduced electric and gas utility charges over the life of the building—are also substantial. In addition, the commissioning effort can potentially lead to non-energy benefits, such as improved occupant comfort and productivity. It is important to note that the long-term benefits that may accrue from commissioning and M&V are highly variable and difficult to predict.

Table 3-4 provides additional details of these benefits, plus all credit impacts.

Table 3-4: Impacts from Energy and Atmosphere Credits

LEED Credit	Credit intent	Actions taken*	Costs**	Benefits**
1.1, 1.2 Optimize energy performance	Exceed energy performance standards to minimize environmental impacts	Implemented various HVAC, lighting, and envelope EEMs (M, J).	• EEM design & implementation (partially offset by utility rebates).	• Reduced utility electric usage & demand, natural gas charges. • Reduced greenhouse gas emissions, offset costs.
3 Additional commissioning	Verify building is designed, constructed, and calibrated to operate as intended.	Hired commissioning agent for design/ construction phase Cx. (M, J).	• Cx agent fees. • Additional city staff labor to assist Cx agent and attend training.	• (same as for 1.1. 1.2 potentially) • Potential benefits to construction team, facilities staff, building occupants (comfort, IAQ, etc.)
5 Measurement and verification	Provide for ongoing optimization of energy, water efficiency measure performance.	Hired commissioning agent or other provider to develop M&V plan. (M, J).	• Cx agent, M&V analyst fees • Costs to install extra sensors. • Increased maintenance/ continuous Cx cost to sustain savings.	• (same as for 1.1. 1.2 potentially, through avoided degradation of EEM energy savings).

* M = Marion Oliver McCaw Performance Hall, J = Seattle Justice Center. EEM=Energy efficiency measure. Cx=Commissioning.
** Shaded costs and benefits have been quantified for this analysis.

3.5 Materials and Resources

The Materials and Resources credit category contains 13 possible points and one prerequisite. Credits in this category focus on minimizing the cradle-to-grave impacts of extracting, manufacturing and transporting virgin building materials. This can be accomplished by reusing building components, recycling construction waste, specifying salvaged or recycled materials, or using local or renewable/sustainable materials. Justice Center took no actions beyond baseline in this category. McCaw Hall specified and obtained recycled content in major items, such as steel, gypsum wallboard, insulation, acoustical ceilings, and carpet. This had a small impact on project costs, and no direct benefits. McCaw Hall also set up contractors to meet a high construction waste recycling target rate —this is discussed in the Innovation and Design credit category in Section 3.7. Table 3-5 provides additional details of costs and benefits for this category.

Table 3-5: Impacts from Materials and Resources Credits

LEED Credit	Credit intent	Actions taken*	Costs**	Benefits**
4.2 Specify recycled content (50%)	Increase demand for building products with recycled content, reducing impacts from extraction of new materials.	Specified recycled content in major items (M).	• Slight material cost increase.	• Reduced environmental impacts from raw material extraction and processing. • Reduced amount of materials to landfill. (both assume specification resulted in higher % recycled materials.)

* M = Marion Oliver McCaw Performance Hall, J = Seattle Justice Center.
** Shaded costs and benefits have been quantified for this analysis.

3.6 Indoor Environmental Quality

The Indoor Environmental Quality credit category contains 15 possible points and two prerequisites. Credits in this category encourage a variety of approaches for improving the health and comfort of building occupants, such as improving ventilation effectiveness, reducing pollutants and contaminants that can lead to poor air quality, and providing occupants with sufficient daylight and control over their spaces. Major actions beyond baseline that the Justice Center and McCaw Hall projects undertook to obtain some of these credits include:

- Adding carbon dioxide monitoring systems (included in Section 3.4 as well), and individual comfort controls in some spaces.

- Taking extra steps during and after construction to safeguard indoor air quality, such as covering ducts, changing filters, and flushing out the building with outside air.

- Specifying low-emitting adhesives, carpeting, and composite wood.

- Adding architectural features, such as a buffer wall (see Section 3.7 as well) and light shelves, to improve daylighting and views.

Overall, these actions increased the design, material, and installation construction costs for the project significantly. Some of the controls may also require additional ongoing maintenance. These actions are expected to yield substantial secondary benefits in terms of increased occupant productivity, particularly at the Justice Center. We quantified the value of these benefits using an approach developed by Paladino, using research from Fisk (refer to Section 2.2-D). Table 3-6 provides additional details of the credit impacts.

Table 3-6: Impacts from Indoor Environmental Quality Credits

LEED Credit	Credit intent	Actions taken*	Costs**	Benefits**
1 Carbon dioxide monitoring	Provide IAQ monitoring to sustain long-term occupant health and comfort.	Added CO_2 monitoring and control system (J, M).	• Monitoring system design & installation. • Additional maintenance requirements.	• Productivity increase from reduced illness and respiratory distress among building occupants.
2 Increase ventilation effectiveness	Provide effective delivery, mixing of fresh air for occupant health, safety, and comfort	Performed calculations to optimize diffuser location (M). Possibly performed ASHRAE testing (J).	• Additional testing, if applicable (J)	
3.1 Construction IAQ management plan (during construction)	Prevent IAQ problems from construction process to sustain long-term occupant and installer health and comfort.	Implemented plan to protect ductwork during construction (M).	• Contractor cost to develop, implement plan.	• Productivity increase from control of toxins and irritants.
3.2 Construction IAQ management plan (before occupancy)		Implemented plan to flush out building, change out filters (J, M).	• Additional energy cost for flushout. • Material, labor costs for new filters.	
4.1, 4.3 Low-emitting materials (adhesives & carpet systems)	Reduce indoor air contaminants to sustain long-term occupant and installer health and comfort.	Specified low-emitting materials (M)	• Negligible incremental cost assumed.	• Negligible incremental benefits assumed.
4.4 Low-emitting materials (composite wood)		Specified low-emitting wood for office furniture (J)	• Increased material costs for workstations.	• Productivity increase from control of toxins and irritants.
6.1, 6.2 Controllability of systems (perimeter & non-perimeter)	Provide high level of individual occupant control of thermal, ventilation, lighting systems to support optimal health, comfort conditions.	Added operable windows, extra lighting/HVAC controls to regularly occupied areas (M).	• Increased HVAC equipment and control costs. • Additional maintenance requirements.	• Productivity increase from increased occupant comfort and control.
8.1 Daylight 75% of spaces	Provide indoor/outdoor connection by adding sunlight, views to occupied areas.	Added buffer wall and light shelf (J)	• Additional design, construction costs.	
8.2 Views for 90% of spaces		Added relights in regularly occupied non-perimeter spaces (M)		

* M = Marion Oliver McCaw Performance Hall, J = Seattle Justice Center.
** Shaded costs and benefits have been quantified for this analysis.

3.7 Innovation and Design Process

The Innovation and Design Process credit category contains up to five points, with no prerequisites. Most of these credits are open-ended, allowing projects to obtain points for greatly exceeding requirements or using innovative approaches. Major actions undertaken to obtain these credits include:

- Adding the thermal buffer wall to improve daylighting and energy performance at the Justice Center (see Section 3.6 as well).
- At McCaw Hall, implementing material salvage, as well as a construction waste recycling plan expected to yield a recycling rate over 75%.
- Installing energy-efficient theatrical lights and providing education about LEED at McCaw Hall.

Overall, these actions increased the design, material, and installation construction costs for the project significantly. They also yielded a wide range of benefits that we quantified, including reduced electric bills, avoided landfill use, and increases in occupant productivity. In addition, these actions may yield other minor, less tangible benefits, such as increased public goodwill and improved aesthetics. Table 3-7 provides additional details of these benefits, plus all credit impacts.

Table 3-7: Impacts from Innovation and Design Process Credits

LEED Credit	Credit intent	Actions taken*	Costs**	Benefits**
1.1(J) Buffer wall	Encourage innovative approaches to meeting Green Building goals, and/or exceptional performance above existing LEED requirements.	Designed and built buffer wall (J).	• Additional design, construction costs.	• Productivity increase from increased occupant comfort. • Enhances aesthetic appeal of facility to community.
1.1(M) Material salvage		Salvaged fixtures and other items for use in other Seattle Center and public facilities (M).	• Additional labor costs.	• Avoided material cost in other buildings. • Avoided disposal cost. • Reduced landfill use. • Public goodwill from associated efforts to salvage previous plants from site, reuse other materials.
1.2 LEED education		Set up LEED education program (M).	• Not known, but assumed negligible.	• Public goodwill and enhanced knowledge of green building practices.
1.3 Efficient theatrical lights		Installed energy-efficient theatrical lighting system (M).	• Increased material costs for lights.	• Reduced utility electric usage & demand charges.
1.4 >75% construction waste recycling.		Established plan for contractor to enhance and document recycling efforts (M).	• Additional labor costs.	• Reduced landfill use from increased recycling rate.

* M = Marion Oliver McCaw Performance Hall, J = Seattle Justice Center.
** Shaded costs and benefits have been quantified for this analysis.

4 Results

This section summarizes important findings from our analysis. These findings are based on the best available information as of now, just prior to the completion of both projects. They represent an initial attempt to analyze a complex, non-linear system, and are subject to future refinements as additional data become available. Presented in this section are estimates of the initial net costs and sustained net benefits for both projects. These numbers are broken into primary and secondary categories, according to their financial impact[4]. The final part of this section discusses the overall benefit-cost ratios for the projects. The appendix contains detailed supporting calculations, information, and summaries from the analysis.

4.1 Initial Net Costs

Initial net costs are the sum of all quantified incremental costs and savings that accrue because of LEED certification during the building design, construction, and start-up process. Examples include the cost of hiring a commissioning agent, or solid waste disposal savings resulting from increased construction waste recycling. The overall increase in the initial net cost of the project that can be attributed to the influence of LEED certification is $909,400 for McCaw Hall. This represents about 0.7% of the overall project budget of $125 million. For the Justice Center, the initial net cost was $1,728,100, which represents 1.9% of the $92 million project budget. Between the two projects, the combined initial net cost was $2,637,500. On a normalized basis, the initial net costs per square foot are $3.08/SF for McCaw Hall and $5.76/SF for the Justice Center.

Table 4-1 breaks down initial net costs further. Primary net costs that accrue directly to the project account for 77%-84% of the total net cost. The remaining percentage consists of project subsidies in the form of expected municipal utility incentive payments to the projects. So, on a combined basis, the City of Seattle is paying 79% of the $2.6 million LEED cost through direct project expenses. The remaining 21% is paid for primarily through Seattle City Light and, to a small extent, through Seattle Public Utilities conservation funding.

Table 4-1 also breaks out the total initial net cost by the six LEED credit categories, thus highlighting the categories that account for most of the cost. For McCaw Hall, actions associated with Energy & Atmosphere—energy efficiency measures, commissioning, and savings verification—account for nearly two-thirds of the initial net cost. Indoor Environmental Quality and Innovation & Design Process actions also account for sizeable portions—20% and 13%, respectively.

The distribution by category is similar for the Justice Center. Again, Energy & Atmosphere—with the same actions as for McCaw Hall—accounts for the majority, or 56% of the cost. Indoor Environmental Quality and Innovation & Design Process actions account for 11% and 29%, respectively. For both projects, Water Efficiency and Materials & Resources actions made up a negligible share of the cost.

Table 4-2 divides the total initial net cost for each project among the six LEED credit categories, and also lists the major elements that comprise those costs.

[4] *Primary* impacts generally result in an easily observable financial effect to the project/building. Examples include decreased water bills or the incremental cost of installing bicycle racks.

Secondary impacts affect the city of Seattle financially, but most likely only have an indirect financial effect on the project/building. Examples include the cost of utility incentives and higher occupant productivity from improved indoor air quality.

Table 4-1: Initial Net Costs to Achieve Silver LEED

	McCaw Hall	Justice Center	Combined
LEED costs for building only*	$765,900	$1,327,300	$2,093,200
LEED costs for city only**	$143,500	$400,800	$544,300
Total LEED cost to city	**$909,400**	**$1,728,100**	**$2,637,500**
Building-only cost as % of total LEED cost	84%	77%	79%
% of total LEED cost in each LEED credit category			
Sustainable Sites	2.1%	3.9%	3.2%
Water Efficiency	-0.3%	0.2%	0.1%
Energy & Atmosphere	64.7%	55.7%	58.8%
Materials & Resources	0.7%	0.2%	0.4%
Indoor Environmental Quality	19.8%	10.9%	14.0%
Innovation & Design Process	13.0%	29.1%	23.5%

* Primary costs, or the General Fund perspective.

** Secondary costs not borne by building/General Fund, e.g., municipal utility incentives.

Table 4-2: Major Elements of Initial Net Costs, by LEED Credit Category

	Initial net costs			
LEED credit category	McCaw Hall	Justice Center	Combined	**Major cost elements***
Sustainable Sites	$16,200	$64,100	$80,300	(M) Bike racks and charging stations. (J) Charging stations, natural gas fueling stations, Green roof, rainwater collection system.
Water Efficiency	-$5,300	$1,500	-$3,800	(M) Irrigation controls, waterless urinals.
Energy & Atmosphere	$585,500	$959,500	$1,545,000	(M, J) Commissioning, M&V plan, energy efficiency measures.
Materials & Resources	$4,000	$0	$4,000	(M) Recycled content for major items.
Indoor Environmental Quality	$177,400	$186,400	$363,800	(M) Additional diffusers, occupant controls, daylighting/views measures, building flushout, construction IAQ management. (J) Light shelf, construction IAQ activities
Innovation & Design Process	$115,000	$500,000	$615,000	(M) Construction recycling plan, material salvage. (J) Buffer wall
LEED administration	*$16,600*	*$16,600*	*$33,200*	(M, J) LEED registration & certification fees, application preparation.
TOTAL	**$909,400**	**$1,728,100**	**$2,637,500**	

* M = Marion Oliver McCaw Performance Hall, J = Seattle Justice Center.

4.2 Sustained Net Benefits

Sustained net benefits are the sum of all quantified cost reductions, ongoing expenses, or added value that persists for an extended period after construction is complete and the building is occupied. Examples include electricity savings from LEED-related energy efficiency measures, and improved indoor air quality. The analysis calculated the sustained net benefits by taking the net present value of the net savings attributed to LEED influence, accrued over a 25-year period. We performed these calculations under two scenarios: with a favorable discount rate of 2%, and with a less favorable rate of 6%. Table 4-3 presents sustained net benefits in both primary and secondary net present value dollars, and provides percentage distributions of these benefits by LEED credit category and by benefit type.

For McCaw Hall, the sustained net benefits ranged from $581,500 to $834,700, for the 6% and 2% discount rates, respectively, nearly all of which were classified as primary. On a normalized basis, the benefits range from $1.97-2.83/SF. For the Justice Center, the sustained net benefits ranged from $2,556,900 to $3,708,000, only 40% of which was classified as primary. The percentage of primary benefits is relatively low because potential occupant productivity benefits, classified as secondary, make up over half of the total project benefits. On a normalized basis, the benefits range from $8.52 - 12.36/SF. The two projects combined produced an aggregate benefit of $3,138,400 to $4,542,700, about 51% of which is primary.

Table 4-3: Expected Net Benefits from Silver LEED

	McCaw Hall		Justice Center		Combined	
	2% discount rate	6% discount rate	2% discount rate	6% discount rate	2% discount rate	6% discount rate
Primary benefits (see Note 2)	$872,900	$606,700	$1,457,000	$1,025,000	$2,329,900	$1,631,700
Secondary benefits (see Note 3)	-$38,200	-$25,152	$2,251,000	$1,531,900	$2,212,800	$1,506,748
TOTAL BENEFITS	**$834,700**	**$581,548**	**$3,708,000**	**$2,556,900**	**$4,542,700**	**$3,138,448**
Primary as % of total	105%	104%	39%	40%	51%	52%
% of total benefits by category (see Notes 4 & 5)						
Sustainable Sites	--		--		--	
Water Efficiency	4.0%		0.0%		0.7%	
Energy & Atmosphere	90.2%		39.6%		49.0%	
Materials & Resources	--		--		--	
Indoor Environmental Quality	5.5%		60.4%		50.2%	
Innovation & Design Process	0.3%		--		0.06%	
% of total benefits by type (see Note 4)						
Primary						
Energy	100.5%		42.3%		53.0%	
Water/sewer	3.6%		0.0%		0.7%	
Other primary	0.4%		-2.7%		-2.1%	
Secondary						
Productivity	5.5%		60.4%		50.3%	
Greenhouse gas reduction	1.8%		-0.1%		0.3%	
Other secondary	-11.8%		0.0%		-2.2%	

Notes

1. All dollar amounts are in net present value dollars, calculated over a 25-year life.
2. Primary benefits are direct, observable financial impacts, such as lower electric bills.
3. Secondary benefits are indirect impacts, such as improved productivity for building occupants.
4. Percentages represent average between 2% and 6% discount rate results.
5. Benefits may be assigned to different category than associated costs, e.g., Justice Center buffer wall costs are under Innovation & Design, but benefits accrue under Indoor Environmental Quality.

Table 4-3 also breaks out the sustained net benefits by the six LEED credit categories, thus highlighting the categories that account for most of the benefits. This classification is somewhat rough, because some actions in one category result in benefits in other categories. An example would be the Justice Center buffer wall, where the initial net costs were placed in the Innovation & Design Process, although associated sustained net benefits accrue to IEQ. As a result, no benefits show up under the Innovation & Design Process category for that project.

For McCaw Hall, actions associated with Energy & Atmosphere—energy efficiency measures, commissioning, and savings verification—account for the vast majority (90%) of the benefit. Indoor Environmental Quality (IEQ) accounts for another 6%, with Water Efficiency making up about 4%. Quantified benefits from the other three categories were negligible. For the Justice Center, virtually all of the benefits fell into two categories, IEQ (60%) and Energy & Atmosphere (40%). Aggregated, about a half of the benefits from the two projects come from Energy & Atmosphere, and the remaining half comes from IEQ, in the form of increased occupant productivity.

Benefits at McCaw Hall from the IEQ category were very small compared to corresponding ones for the Justice Center, reflecting the fact that McCaw Hall has very few full-time building occupants. IEQ benefits are directly proportional to the number of occupants. The preliminary estimate of the number of full-time employees at McCaw Hall is six, compared to 800 at the Justice Center. Low occupancy at McCaw Hall results in relatively low benefits from Energy & Atmosphere actions, such as energy optimization and commissioning, since the building systems equipment tends to run much less than at an office complex.

The breakdown by benefit type at the bottom of Table 4-3 shows a similar distribution to the breakdown by credit category. Again, the primary benefit of energy predominates at McCaw Hall, although it is offset somewhat by a negative secondary benefit for the increased O&M activities necessary to maintain energy efficiency performance. At the Justice Center, the majority of the benefits are from increased productivity, with a significant share from energy as well. This corresponds almost exactly to the IEQ/Energy & Atmosphere credit category breakdown. Aggregated, about a half of the benefits from the two projects come from energy, and the remaining half comes from increased occupant productivity from improved IEQ.

4.3 Benefit-Cost Ratios

Dividing the sustained net benefits from Section 4.2 by the initial net costs from Section 4.1 yields the benefit-cost ratios (BCR) for the projects. A BCR greater than one indicates that a project is cost-effective over its lifetime; conversely, a ratio below one indicates that the costs ultimately outweigh the lifetime benefits.

Table 4-4 shows BCRs for three perspectives. The first, most narrow perspective examines only the primary impacts, that is, only the direct costs and benefits that accrue to the building/General Fund. With this criterion, the BCR for McCaw Hall ranges from 0.79 to 1.14, depending on the discount rate assumed. Similarly, the Justice Center BCR ranges from 0.77 to 1.10. The BCR for the two projects combined is 0.78 to 1.11.

The second perspective is wider, and considers both primary and secondary costs and benefits that accrue to the building/General Fund. Adding secondary impacts leaves the McCaw Hall BCRs virtually unchanged, but those for the Justice Center increase dramatically to 1.93 to 2.80, so that combined, the BCRs range from 1.49 to 2.16. This increase is driven by the huge occupant productivity benefits associated with IEQ improvements. Over the 25-year study life, these benefits have a net present value of $1.5-$2.3 million. Because this figure significantly influences the cost-effectiveness of LEED

certifications, we performed a sensitivity analysis to determine the effect of downgrading the productivity benefits. We found that even after reducing the value of the productivity benefit by over half, the overall BCR for the Justice Center still exceeded 1.0 (conservatively assuming a 6% discount rate, and including both primary and secondary impacts).

Table 4-4: Benefit-Cost Ratios for Silver LEED Certification

	McCaw Hall		Justice Center		Combined	
Perspective	2% discount rate	6% discount rate	2% discount rate	6% discount rate	2% discount rate	6% discount rate
1. General fund perspective - primary costs & benefits to building (i)	1.14	0.79	1.10	0.77	1.11	0.78
2. General fund perspective - primary & secondary costs & benefits to building (ii)	1.07	0.74	2.80	1.93	2.16	1.49
3. Citywide perspective - all costs & benefits (iii)	**0.92**	**0.64**	**2.15**	**1.48**	**1.72**	**1.19**

(i) Primary = direct, observable financial impacts, e.g., costs of bike racks, lower electric bills.

(ii) Secondary = indirect costs and benefits, e.g., productivity benefits.

(iii) Also includes the portion of conservation measures paid for through municipal utility incentives.

The final perspective combined all impacts, primary and secondary, and affecting both the building and the City of Seattle. This is the overall citywide perspective. Thus considered, BCRs for McCaw Hall all fall under one (0.64 to 0.92), while those for the Justice Center range from 1.48 to 2.15, still quite cost-effective. This drop in the BCRs results primarily because this perspective includes the cost of utility incentive payments. The combined BCR range of 1.19 to 1.72 indicates that for these buildings considered together, LEED certification has been cost-effective to the City.

Table 4-5 shows BCRs by credit category, for the 2% discount rate scenario considering all impacts. This classification is somewhat rough, because some actions could potentially be placed in two or more categories. An example would be carbon dioxide monitoring, where the initial net costs were placed in the Energy & Atmosphere category, although associated sustained net benefits accrue to both Energy & Atmosphere and IEQ. This makes the IEQ BCR somewhat higher and the Energy & Atmosphere BCR somewhat lower than if the costs were somehow apportioned between the categories. For the sake of clarity, we assigned all costs to the credit category that according to the information at our disposal, appeared to be the predominant rationale for the action. So in the preceding example, installing carbon dioxide monitoring appeared driven by energy efficiency concerns, with IEQ being secondary. As a result, we assigned the cost to the Energy & Atmosphere category.

Nonetheless, the category-level BCRs reveal some important results. The only category that yielded BCRs greater than one for both projects was Energy & Atmosphere. The combined BCR for both projects was 1.42. Results were mixed for Water Efficiency, where related actions (mostly installing waterless urinals) at McCaw Hall both reduced initial costs and yielded sustained net benefits, an extremely positive outcome. Corresponding actions at the Justice Center resulted in a low BCR, but the combined BCR was a very favorable 19.06. Similarly, BCRs for the IEQ category were low at McCaw and very high at Justice Center, for an aggregate 6.23.

Table 4-5: Benefit-Cost Ratios by Credit Category (2% discount rate, all impacts)

LEED credit category	McCaw Hall	Justice Center	Combined
Sustainable Sites	0.00	0.00	0.00
Water Efficiency	N/A*	0.09	19.06
Energy & Atmosphere	1.28	1.51	1.42
Materials & Resources	0.00	0.00	0.00
Indoor Environmental Quality	0.26	11.91	6.23
Innovation & Design Process	0.02	0.00	0.00

* LEED resulted in net cost reduction, so BCR not applicable.

Note on BCRs: Benefits may be assigned to different category than costs, resulting in BCR=0 in some cases. For example, Justice Center buffer wall costs are under Innovation & Design, but benefits accrue under Indoor Environmental Quality.

5 Conclusions

5.1 Cost-Effectiveness of LEED Certification

The results presented in Section 4 and associated analysis yielded these conclusions about the City's Sustainable Building Policy, and in particular about the LEED Silver Rating requirement.

A) **For the two studied projects combined, LEED-influenced actions are cost-effective.** Our analysis concluded that the City of Seattle's investment of an additional $2.64 million to obtain LEED Silver certification for the Justice Center and McCaw Hall projects is cost-effective when examined over a 25-year period. The combined long-term net benefits from LEED for both projects from the perspective of the City General Fund are 49% to 116% higher (depending on the discount rate assumed) than the initial net costs associated with certification. Even adopting a broader citywide perspective that encompasses cost contributions from Seattle City Light and Seattle Public Utilities, the combined long-term benefits are 19% to 72% higher than the costs.

B) **Occupancy significantly affects the cost-effectiveness of LEED actions**: We also found that cost-effectiveness varied significantly between the two projects. From the City General Fund perspective, the McCaw Hall project was only marginally cost-effective, with benefits ranging from 26% less to 7% more than the costs. Benefits for the Justice Center project, by comparison, exceeded costs by 93% to 180%. This variation comes primarily from the fact that the Justice Center has very high occupancy, with an estimated 800 full-time occupants, compared to McCaw Hall, which is projected to hold a mere six full-time occupants. Occupancy directly affects energy use and indoor environmental quality, the two areas where LEED certification had the largest impact. This suggests that any future strategy on the part of the City to maximize the economic benefits obtained from LEED certification expenditures should take into account building occupancy and usage patterns, and allocate funds accordingly.

C) **City should consider refining methods for selecting LEED credits to pursue**: It was beyond the scope of this study to evaluate the process by which each project decided which credits to pursue and which strategies to employ to obtain sufficient points to meet the LEED Silver threshold. Nonetheless, it became clear during our analysis that this process was complex and involved many factors—first costs, schedules, technical feasibility, architectural and aesthetic concerns, and desires to demonstrate new technologies.

   However, City projects could benefit from a standardized process early during the project design for selecting the most suitable LEED credits. Performing preliminary credit-by-credit benefit-cost analyses can help ensure that the maximum number of credit points necessary for LEED silver certification is obtained at the minimum incremental cost. For instance, points that can be obtained readily from actions that are already standard practice should almost without exception be included. Points that will result in significant initial net costs should be carefully examined to verify that they would also yield correspondingly significant benefits.

   Another means of enhancing the credit selection process would be to document the rationale behind selecting particular credits for each project, as well as the expected costs and benefits. This information could be compared to the actual costs and benefits, when available, to assess whether particular credits performed as expected. This feedback could generate valuable lessons and adjustments that could help future building projects obtain LEED certification most efficiently and cost-effectively.

5.2 Applicability of Results Beyond Seattle

Differences between economic and regulatory situations in various parts of the country make it difficult to compare LEED projects with similar ratings[5]. In other words, a LEED Silver building in Seattle may have a very different environmental impact than a LEED Silver building in another part of the country. The Seattle area has particularly strict codes, regulations, and policies intended to protect the environment. Examples of these already in place include:

- More stringent energy code than ASHRAE/IESNA Standard 90.1-1999.
- Prohibitions on single-pass HVAC cooling.
- Environmental tobacco smoke control requirements.
- Policies encouraging low-emitting adhesives, sealants, paints, and carpet systems.
- Carpool preference policies.
- Recycling area requirements.

As a result of these existing requirements, many of the LEED actions that the two projects we studied took were considered baseline, with no initial net costs or sustained net benefits. In other areas of the country with less stringent requirements, these same actions on other projects would have net costs and benefits that would alter the benefit-cost ratios for these other projects. Whether they would increase or decrease the cost-effectiveness is unknown. The clear implication, however, is that care must be taken in applying these results to projects outside of Seattle.

5.3 Uncertainties Inherent in Analysis

Because of the timeframe for this study, data collection and analysis took place while both projects were under construction. As a result, some of the data necessary to accurately quantify costs and benefits were not yet fully available. In addition, the project teams had not yet prepared the necessary LEED application documentation, so much of the analysis was based upon the judgment of the City project managers and their design teams. Specific information about actions taken, as well as the associated costs and benefits, may change in the future as project team members find out more about what actually occurred on the projects.

In addition, many of the most significant sustained net benefits from LEED actions, namely energy savings and IEQ-related productivity increases, are necessarily based on key assumptions. These assumptions fall generally into these three interrelated areas:

- Building Operations: Design-stage modeling of building energy performance must out of necessity make many assumptions about how building systems are operated (such as HVAC scheduling and thermostat setpoints), when and how many people will occupy the facility, what sort of other loads (such as office equipment) will be in use, and many other factors. Actual conditions once the buildings are in use will undoubtedly be different that initially assumed. These differences introduce a large measure of uncertainty into the estimates of building energy use, as well as savings from energy efficiency measures.

[5] This conclusion has been reported as well by Scheuer and Keoleian in their report, *Evaluation of LEED using Life Cycle Assessment Methods* (NIST# GCR 02-836), published by the National Institute of Standards and Technology (NIST) in September 2002. This study examined cradle-to-grave impacts of Materials & Resources and Energy & Atmosphere credits at a university building.

In a related matter, IEQ benefits are currently based on assumed building occupancies. If actual occupancies are significantly different, then the magnitude of these benefits will also change. The method by which productivity benefits associated with improved IEQ are now calculated is also open to future revision, as subsequent building research provides better tools for quantifying these impacts.

- Commissioning: The actual energy-related benefits from resolving issues uncovered by commissioning during project construction and startup can vary tremendously from building to building. Our analysis used the best available prediction, based on findings at other buildings. But until the commissioning process is complete, the true magnitude of these benefits is unknown. In addition, building operations staff may decide to implement a continuous commissioning process to maintain energy and water system performance over the long term. Potential benefits from such efforts cannot be known in advance.

- Measurement &Verification: The benefits from the M&V plans are wholly contingent on the nature of deficiencies that are revealed when the plans are executed and how the buildings choose to rectify these deficiencies.

Our analysis included what we felt were prudent assumptions about all of the factors mentioned above, but should actual conditions be significantly different, the associated sustained net benefits may also be very different. Since energy impacts in particular are so significant, any changes in the assumed long-term benefit stream may dramatically affect the benefit-cost ratios for these projects.

5.4 Guidelines for Future Evaluation Work

The previous section highlighted the main uncertainties in our analysis. SOSE is considering future follow-up evaluations to refine the benefit and cost estimates for the two projects. Details of the proposed methodology for such follow-up work can be found in separate documents. To summarize the suggested approach, it calls for reevaluating the benefit-cost ratios using data from many sources, including:

1. Final LEED application submitted to the USGBC.
2. Latest literature and methodology from SOSE and other sources regarding the quantification of secondary impacts, such as improved productivity, from LEED actions.
3. Final M&V documentation
4. Final commissioning reports.
5. Other LEED-related documentation prepared after certification with information about costs and benefits of LEED actions beyond baseline.
6. Utility documentation of final incentives amounts.
7. Utility billing records.
8. Actual LEED registration, certification, and application preparation costs.
9. Interviews with City project managers, key design and construction team members, and facilities staff.

Information from these sources will form the basis for revising and improving the analysis described in this report, and generating final benefit-cost results for the two projects.

6 Appendix

This appendix contains both summaries and key details of the analysis inputs, calculations, and summarizations performed for this study. It is divided into three sections, each of which is described briefly below:

6.1 Credit Matrices: Each of the two projects has a credit matrix, based on the LEED Checklist template provided by the USGBC. This matrix lists all 69 credits and seven prerequisites in the six credit categories, and indicates which ones the project intends to apply for. It also contains four columns that list, for each credit, a qualitative summary of the information collected about: (1) Actions—specific actions taken to get the credit/prerequisite, (2) Baseline—what would have been done anyway in the absence of LEED, (3) Benefits—incremental $ benefits, if any, from the actions, and (4) Costs—incremental costs, if any, for the actions.

6.2 Category-Level Analysis Summary Sheets and Key Supporting Calculations: Study documentation for each project includes six Category-Level Analysis Summary Sheets, one for each LEED credit category. Each sheet summarizes net initial costs and first-year impacts for all actions beyond baseline that affect that credit category. These costs and impacts correspond to those listed in the credit matrices. As necessary, these totals are broken out into detail by credit, with notes that explain important assumptions and inputs. The bottom of each summary sheet shows the quantified life-cycle benefits in net present value dollars at 2% and 6% discount rates, broken down into various primary and secondary benefits.

For critical categories, such as Energy & Atmosphere and Indoor Environmental Quality, additional sheets are included that provide further details about the values on the summary sheets.

6.3 General Economic Assumptions: Contains all economic assumptions underlying the analysis.

6.4 Project Analysis Summary Sheets: The life-cycle cost analysis for each project is summarized on a single Project Analysis Summary Sheet. This sheet breaks out the initial net costs and sustained net savings for the six credit categories. These numbers provide the basis for calculating various benefit-cost ratios (BCRs), both by credit category and overall. These BCRs are shown at the bottom of each sheet.

6.1 Credit Matrices

6.1.1 McCaw Hall

LEED Project Checklist

Yes	No				**Actions**: What specific actions have been taken to get this credit/prerequisite?	**Baseline**: What would have been done anyway in the absence of LEED?	**Benefits**: What are the incremental $ benefits, if any, from these actions?	**Costs**: What are the incremental costs, if any, for these actions?
8	6	**Sustainable Sites**	14 Points					
Y		Prereq 1	**Erosion & Sedimentation Control**	Required	*None beyond baseline.*	Standard measures required by county codes.	N/A	N/A
Y		Credit 1	**Site Selection**	1	*None beyond baseline.*	Same siting, as dictated by city property considerations. No LEED influence.	N/A	N/A
Y		Credit 2	**Urban Redevelopment**	1	*None beyond baseline.*	Same siting, as dictated by city property considerations. No LEED influence.	N/A	N/A
	N	Credit 3	**Brownfield Redevelopment**	1				
Y		Credit 4.1	**Alternative Transportation**, Public Transportation Access	1	*None beyond baseline.*	Nothing. Location already well-served by public transportation.	N/A	N/A
Y		Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1	**Added bike racks, instituted policy for dressing room shower use by Seattle Center staff.**	No action.	None quantified.	Cost of 8-foot bike rack.
Y		Credit 4.3	**Alternative Transportation**, Alternative Fuel Refueling Stations	1	**Added electric charging station for Seattle Center maintenance scooter fleet.**	No action.	None quantified.	Cost of charging station.
Y		Credit 4.4	**Alternative Transportation**, Parking Capacity	1	*None beyond baseline.*	No added parking capacity	N/A	N/A
	N	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1				
	N	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1				
	N	Credit 6.1	**Stormwater Management**, Rate or Quantity	1				
	N	Credit 6.2	**Stormwater Management**, Treatment	1				
Y		Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1	*None beyond baseline.*	Added scrim and tree shading.	N/A	N/A
Y		Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1	**Specified EnergyStar roof to meet LEED reflectivity/emissivity requirements.**	Installed standard EnergyStar roof	None quantified--assumed negligible energy impact.	None.
	N	Credit 8	**Light Pollution Reduction**	1				

Yes	No						
2	3	**Water Efficiency**	**5** Points				
Y		Credit 1.1 **Water Efficient Landscaping**, Reduce by 50%	1	**Small landscaped area has timed/controlled irrigation. Plant selection not influenced.**	Center has had efficient landscaping practices for some time. Used city standard practices as baseline.	Water savings (no sewer savings). Associated plant salvage generated public interest and goodwill (not quantified).	Cost of additional irrigation controls. Plant salvage costs not included.
	N	Credit 1.2 **Water Efficient Landscaping**, No Potable Use or No Irrigation	1				
	N	Credit 2 **Innovative Wastewater Technologies**	1				
Y		Credit 3.1 **Water Use Reduction**, 20% Reduction	1	**None beyond baseline measures, except waterless urinals.**	Installed closed-loop HVAC cooling, waterless urinals, water-efficient kitchen equipment, and motion sensor faucets. Also reduced overall seating capacity.	Water & sewer savings. Decreased plumbing costs.	Incremental cost for waterless urinals.
	N	Credit 3.2 **Water Use Reduction**, 30% Reduction	1				

Yes	No							
6	11	**Energy & Atmosphere**	**17** Points					
Y		Prereq 1	**Fundamental Building Systems Commissioning**	Required	<see EA3>	<see EA3>	<see EA3>	<see EA3>
Y		Prereq 2	**Minimum Energy Performance**	Required	<see EA1.2>	<see EA1.2>	<see EA1.2>	<see EA1.2>
Y		Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required	*None beyond baseline.*	Mechanical cooling already provided by central utility plant.	N/A	N/A
Y		Credit 1.1	**Optimize Energy Performance**, 20% New / 10% Existing	2	<see EA1.2>	<see EA1.2>	<see EA1.2>	<see EA1.2>
Y		Credit 1.2	**Optimize Energy Performance**, 30% New / 20% Existing	2	**Various energy efficiency measures (EEMs) affecting: lobby cooling, HVAC distribution systems & controls, lighting fixtures & controls.**	No action beyond Seattle Energy Code. Assumed all EEMS resulted because of LEED.	Electric usage & demand savings, natural gas savings, greenhouse gas emissions impacts (offset costs).	Costs to identify, design, and install EEMs, offset by utility incentives.
	N	Credit 1.3	**Optimize Energy Performance**, 40% New / 30% Existing	2				
	N	Credit 1.4	**Optimize Energy Performance**, 50% New / 40% Existing	2				
	N	Credit 1.5	**Optimize Energy Performance**, 60% New / 50% Existing	2				
	N	Credit 2.1	**Renewable Energy**, 5%	1				
	N	Credit 2.2	**Renewable Energy**, 10%	1				
	N	Credit 2.3	**Renewable Energy**, 20%	1				
Y		Credit 3	**Additional Commissioning**	1	**Hired commissioning agent for design and construction phases.**	No action.	Electric usage & demand savings, natural gas savings, reduced greenhouse gas emissions (avoided offset cost). Potential construction cost savings assumed neglible. Productivity increase from improved IEQ assumed covered through EQ credits.	Cx agent fees, less utility incentives. City staff cost to administer contract & assist agent.
	N	Credit 4	**Ozone Depletion**	1				
Y		Credit 5	**Measurement & Verification**	1	**Hired commissioning agent to develop M&V plan and oversee implementation.**	Various monitoring points would have been tied into the campus energy management system anyway.	No additional benefits beyond ensuring that savings from EA-1.2 and EA-3 do not degrade over the lifetime of the building.	Cost for developing plan included in Cx agent budget. Assumed ongoing O&M cost for continuous commissioning of building equipment.
	N	Credit 6	**Green Power**	1				

Yes	No							
5	8	**Materials & Resources**	**13** Points					
Y		Prereq 1	**Storage & Collection of Recyclables**	Required	*None beyond baseline.*	Recycling setup per standard practice.	N/A	N/A
	N	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1				
	N	Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1				
	N	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1				
Y		Credit 2.1	**Construction Waste Management**, Divert 50%	1	<see ID 1.4>	<see ID 1.4>	<see ID 1.4>	<see ID 1.4>
Y		Credit 2.2	**Construction Waste Management**, Divert 75%	1	<see ID 1.4>	<see ID 1.4>	<see ID 1.4>	<see ID 1.4>
	N	Credit 3.1	**Resource Reuse**, Specify 5%	1				
	N	Credit 3.2	**Resource Reuse**, Specify 10%	1				
Y		Credit 4.1	**Recycled Content**, Specify 25%	1	<see MR 4.2>	<see MR 4.2>	<see MR 4.2>	<see MR 4.2>
Y		Credit 4.2	**Recycled Content**, Specify 50%	1	**Specified recycled content in major items, such as structural steel, metal cladding, general steel, gypsum board, concrete flyash, and carpet.**	Nearly the same actions. Most materials, such as steel, already contain large percentages of rrecycled content.	None quantified.	Small incremental cost for major items.
Y		Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1	*None beyond baseline. Center cannot constrain bidding to local firms to promote competitive pricing.*	Steel, curtainwall, and gypsum probably produced locally, but not because of LEED influence.	N/A	N/A
	N	Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1				
	N	Credit 6	**Rapidly Renewable Materials**	1				
	N	Credit 7	**Certified Wood**	1				

Yes	No							
14	**1**	**Indoor Environmental Quality**	**15** Points					
Y		Prereq 1	**Minimum IAQ Performance**	Required	*None beyond baseline.*	Compliance w/ASHRAE Std. 62-1999 assumed (std industry practice).	N/A	N/A
Y		Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required	*None beyond baseline.*	Done as part of city policy.	N/A	N/A
Y		Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1	Added CO2 monitoring and control system (see credit EA-1.2)	Standard ventilation controls.	Energy savings included under credit EA-1.2. Productivity increase from reduction in communicable respiratory diseases.	Costs included under credit EA-1.2
Y		Credit 2	**Increase Ventilation Effectiveness**	1	**Performed ADPI calculations to determine best diffuser locations in regularly occupied office spaces.**	Installed diffusers without ADPI calculation process.	Productivity increase from reduction in communicable respiratory diseases.	None.
Y		Credit 3.1	**Construction IAQ Management Plan**, During Construction	1	**Developed & implemented plan for protection of ductwork during construction.**	No action.	Productivity increase from control of toxins & irritants.	Contractor cost to develop and implement plan.
Y		Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1	**Developed & implemented air quality monitoring plan, including plan for flushing spaces.**	No action.	Productivity increase from control of toxins & irritants.	Additional energy cost for flushout, plus cost to change out filters. No quantification of any delays in work schedule.
Y		Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1	**Specified low-emitting materials.**	No action.	Assumed negligible impact because city policy already calls for similar products.	Assumed negligible impact because city policy already calls for similar products.
	N	Credit 4.2	**Low-Emitting Materials**, Paints					
Y		Credit 4.3	**Low-Emitting Materials**, Carpet	1	**Specified low-emitting materials (Green Seal).**	No action.	Assumed negligible impact because city policy already calls for similar products.	Assumed negligible impact because city policy already calls for similar products.
Y		Credit 4.4	**Low-Emitting Materials**, Composite Wood	1	*None beyond baseline.*	Specified low-emitting materials, although exception required for wood veneer panels.	N/A	N/A
Y		Credit 5	**Indoor Chemical & Pollutant Source Control**	1	*None beyond baseline.*	Installed walk-off mats and separately ventilated storage spaces.	N/A	N/A
Y		Credit 6.1	**Controllability of Systems**, Perimeter	1	**Added operable windows and lighting controls in regularly occupied spaces. Added separate perimeter FPVAV boxes w/controls to disable HVAC when windows are open.**	Installed individual light switches in each perimeter office.	Productivity increase from increased occupant comfort.	Cost of additional HVAC equipment and controls.
Y		Credit 6.2	**Controllability of Systems**, Non-Perimeter	1	**Added FPVAV boxes and lighting controls to provide better occupant control.**	Installed minimal lighting/HVAC controls.	Productivity increase from increased occupant comfort.	Cost of additional HVAC equipment and controls.
Y		Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1	*None beyond baseline.*	Set zoning and diffuser locations to comply with ASHRAE 55-1992.	N/A	N/A
Y		Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1	*None beyond baseline.*	DDC system set up to monitor each zone temperature.	N/A	N/A
Y		Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1	**Added relights in regularly occupied non-perimeter spaces.**	No relights.	Productivity increase from increased occupant comfort.	Cost to add relights.
Y		Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1	**Added relights in regularly occupied non-perimeter spaces.**	No relights.	Productivity increase from increased occupant comfort.	Cost to add relights.

Yes	No						
5		**Innovation & Design Process**	**5** Points				
Y		Credit 1.1 **Innovation in Design**: Material Salvage	1	**Material salvage (used in other campus buildings)**	Some, but not all of salvage that was done.	Avoided costs in other campus buildings. Delayed replacement benefit, plus public goodwill and small avoided disposal cost not quantified.	Included in Credit ID-1.4.
Y		Credit 1.2 **Innovation in Design**: LEED Education	1	**LEED education**	No action.	Public goodwill and enhanced knowledge of green building practices (none quantified).	Not known--assumed minimal.
Y		Credit 1.3 **Innovation in Design**: Efficient Theatrical Lights	1	**Installed energy-efficient theatrical lights**	Installed lowest-price industry standard lighting.	Reduced electrical usage (included in credit EA-1.2)	Incremental installation cost (included in credit EA-1.2)
Y		Credit 1.4 **Innovation in Design**: > 75% Construction Waste Recycling	1	**>75% construction waste recycling (required extra effort: one onsite person, add'l space, dumpsters, coordination, & project management)**	No action (although much of the waste streams would have been recycled anyway, per standard practices).	Reduced disposal costs (savings assumed to accrue to contractors). Avoided disposal costs for salvaged materials. Slightly reduced greenhouse gas emissions.	Contractor adder to implement plan.
Y		Credit 2 **LEED™ Accredited Professional**	1	*None beyond baseline.*	Accredited professional already on project team.	N/A	N/A

Yes	No		
40	**29**	**Project Totals**	**69** Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

6.1.2 Justice Center

LEED Project Checklist

Yes	No				Actions: What specific actions have been taken to get this credit/prerequisite?	Baseline: What would have been done anyway in the absence of LEED?	Benefits: What are the incremental $ benefits, if any, from these actions?	Costs: What are the incremental costs, if any, for these actions?
10	4	**Sustainable Sites**	14 Points					
Y		Prereq 1	**Erosion & Sedimentation Control**	Required	*None beyond baseline.*	Standard measures required by county codes.	N/A	N/A
Y		Credit 1	**Site Selection**	1	*None beyond baseline.*	Same siting, as dictated by city property considerations. No LEED influence.	N/A	N/A
Y		Credit 2	**Urban Redevelopment**	1	*None beyond baseline.*	Same siting, as dictated by city property considerations. No LEED influence.	N/A	N/A
	N	Credit 3	**Brownfield Redevelopment**	1				
Y		Credit 4.1	**Alternative Transportation**, Public Transportation Access	1	*None beyond baseline.*	Nothing. All downtown locations well-served by public transportation.	N/A	N/A
	N	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1				
Y		Credit 4.3	**Alternative Transportation**, Alternative Fuel Refueling Stations	1	**Installed electric charging stations and natural gas fueling stations.**	No action.	None quantified.	Cost of charging and fueling stations.
Y		Credit 4.4	**Alternative Transportation**, Parking Capacity	1	*None beyond baseline.*	Bought garage to share with adjacent building. Continued DCLU policy of carpool parking preference. No LEED influence.	N/A	N/A
Y		Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1	**Installed Green Roof and plaza landscaping.**	Plaza landscaping required by code.	Quantified through other credits.	Quantified through other credits.
Y		Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1	Bought alley between garage and building to expand public space.	Either bought alley/relocated underground utilities, or built skybridge.	None quantified.	Both options had nearly the same cost, so LEED influence is cost-neutral.
Y		Credit 6.1	**Stormwater Management**, Rate or Quantity	1	**Installed Green Roof and rainwater collection system. Increased stormwater retention tank size slightly.**	Installed slightly smaller stormwater retention tank.	None quantified.	Small increment for larger stornwater retention tank. Green Roof & rainwater collection system costs included with other credits.
	N	Credit 6.2	**Stormwater Management**, Treatment	1				
	N	Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1				
Y		Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1	**Installed Green Roof and white membrane roof.**	Installed standard membrane roof only.	Quantified through other credits.	Green roof cost quantified through other credits. No cost for changing membrane color.
Y		Credit 8	**Light Pollution Reduction**	1	*None beyond baseline.*	Installed LEED-compliant fixtures already specified by Seattle Building Code.	N/A	N/A

Yes	No							
2	3	**Water Efficiency**	**5** Points					
Y		Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1	<see WE-1.2>	<see WE-1.2>	<see WE-1.2>	<see WE-1.2>
Y		Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1	**Installed Green Roof (no supplemental irrigation needed) & rainwater storage system to water plaza plants.**	No action.	Water savings (no sewer savings)	Green Roof & rainwater collection system costs, offset by utility incentives.
	N	Credit 2	**Innovative Wastewater Technologies**	1				
	N	Credit 3.1	**Water Use Reduction**, 20% Reduction	1				
	N	Credit 3.2	**Water Use Reduction**, 30% Reduction	1				

Yes	No							
6	11	**Energy & Atmosphere**	**17** Points					
Y		Prereq 1	**Fundamental Building Systems Commissioning**	Required	<see EA-3>	<see EA-3>	<see EA-3>	<see EA-3>
Y		Prereq 2	**Minimum Energy Performance**	Required	<see EA-1.2>	<see EA-1.2>	<see EA-1.2>	<see EA-1.2>
Y		Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required	*None beyond baseline.*	Non-CFC equipment now standard practice for new buildings.	N/A	N/A
Y		Credit 1.1	**Optimize Energy Performance**, 20% New / 10% Existing	2	<see EA-1.2>	<see EA-1.2>	<see EA-1.2>	<see EA-1.2>
Y		Credit 1.2	**Optimize Energy Performance**, 30% New / 20% Existing	2	**Various energy efficiency measures (EEMs) affecting: chillers, lighting fixtures & controls, HVAC distribution/heat rejection system & controls, and building envelope. Buffer wall included under ID-1.1.**	No action beyond Seattle Energy Code. Assumed all EEMs resulted because of LEED.	Electric usage & demand savings, natural gas impacts, greenhouse gas emissions impacts (offset costs)	Costs to identify, design, and install EEMs, offset by utility incentives.
	N	Credit 1.3	**Optimize Energy Performance**, 40% New / 30% Existing	2				
	N	Credit 1.4	**Optimize Energy Performance**, 50% New / 40% Existing	2				
	N	Credit 1.5	**Optimize Energy Performance**, 60% New / 50% Existing	2				
	N	Credit 2.1	**Renewable Energy**, 5%	1				
	N	Credit 2.2	**Renewable Energy**, 10%	1				
	N	Credit 2.3	**Renewable Energy**, 20%	1				
Y		Credit 3	**Additional Commissioning**	1	**Hired commissioning agent for design and construction phases.**	No action.	Energy savings. Potential construction cost savings assumed neglible. Productivity increase from improved IEQ assumed covered through EQ credits.	Cx agent fees, less utility incentives. City staff cost to administer contract & assist agent.
	N	Credit 4	**Ozone Depletion**	1				
Y		Credit 5	**Measurement & Verification**	1	**Hired commissioning agent to develop M&V plan and oversee implementation.**	No action.	No additional benefits beyond ensuring that savings from EA-1.2 and EA-3 do not degrade over the lifetime of the building.	Cost for developing plan included in Cx agent budget. Assumed ongoing O&M cost for continuous commissioning of building equipment.
	N	Credit 6	**Green Power**	1				

Yes	No							
2	11	**Materials & Resources**	**13** Points					
Y		Prereq 1	**Storage & Collection of Recyclables**	Required	*None beyond baseline.*	Recycling setup per standard practice.	N/A	N/A
	N	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1				
	N	Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1				
	N	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1				
Y		Credit 2.1	**Construction Waste Management**, Divert 50%	1	<see MR-2.2>	<see MR-2.2>	<see MR-2.2>	<see MR-2.2>
Y		Credit 2.2	**Construction Waste Management**, Divert 75%	1	*None beyond baseline.*	Waste management per contractor standard practice.	N/A	N/A
	N	Credit 3.1	**Resource Reuse**, Specify 5%	1				
	N	Credit 3.2	**Resource Reuse**, Specify 10%	1				
	N	Credit 4.1	**Recycled Content**, Specify 25%	1				
	N	Credit 4.2	**Recycled Content**, Specify 50%	1				
	N	Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1				
	N	Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1				
	N	Credit 6	**Rapidly Renewable Materials**	1				
	N	Credit 7	**Certified Wood**	1				

Yes	No							
12	**3**	**Indoor Environmental Quality**	**15** Points					
Y		Prereq 1	**Minimum IAQ Performance**	Required	*None beyond baseline.*	Per standard practice.	N/A	N/A
Y		Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required	*None beyond baseline.*	Done as part of city policy.	N/A	N/A
Y		Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1	Added CO2 monitoring and control system (see credit EA-1.2)	Standard ventilation controls.	Energy savings included under credit EA-1.2. Productivity increase from reduction in communicable respiratory diseases.	Costs included under credit EA-1.2
Y		Credit 2	**Increase Ventilation Effectiveness**	1	**No design changes. City may choose to perform ASHRAE 129-1997 test to obtain this point.**	Standard design practices.	N/A	Possible cost of ASHRAE 129-1997 testing.
Y		Credit 3.1	**Construction IAQ Management Plan**, During Construction	1	*None beyond baseline.*	Per standard practice, e.g., protection during fireproofing spraying.	N/A	N/A
Y		Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1	**Two-week 100% outside air flush, changeout of special MERV filters.**	No action.	Productivity increase from control of toxins & irritants.	Additional energy cost for flushout, plus cost to change out filters. No quantification of 2-week delay in work schedule.
Y		Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1	*None beyond baseline.*	Specified per city policy to mitigate tenant concerns.	N/A	N/A
Y		Credit 4.2	**Low-Emitting Materials**, Paints	1	*None beyond baseline.*	Specified per city policy to mitigate tenant concerns.	N/A	N/A
Y		Credit 4.3	**Low-Emitting Materials**, Carpet	1	*None beyond baseline.*	Specified per city policy to mitigate tenant concerns.	N/A	N/A
Y		Credit 4.4	**Low-Emitting Materials**, Composite Wood	1	*None beyond baseline (wood furniture/workstations not included under LEED 2.0).*	No action.	N/A	N/A
Y		Credit 5	**Indoor Chemical & Pollutant Source Control**	1	*None beyond baseline.*	Added grille/grate to entrances, provided separate exhaust for copy/print rooms.	N/A	N/A
	N	Credit 6.1	**Controllability of Systems**, Perimeter	1				
	N	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1				
Y		Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1	<see EQ-7.2>	<see EQ-7.2>	<see EQ-7.2>	<see EQ-7.2>
Y		Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1	Added monitoring system.	No action.	Productivity increase from control of toxins & irritants.	Monitoring system cost (difficult to determine)
Y		Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1	**Added buffer wall (see ID-1.1) and light shelf.**	LEED had some influence on these actions.	Productivity increase from increased comfort control.	Majority of light shelf cost associated w/LEED. Cost of buffer wall included in credit ID-1.1.
	N	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1				

Yes	No							
2	**3**	**Innovation & Design Process**	**5** Points					
Y		Credit 1.1	**Innovation in Design**: Buffer wall	1	**Added buffer wall.**	LEED had some influence on this action.	Productivity increase from increased comfort control.	Portion of total $1M cost.
	N	Credit 1.2	**Innovation in Design**:	1				
	N	Credit 1.3	**Innovation in Design**:	1				
	N	Credit 1.4	**Innovation in Design**:	1				
Y		Credit 2	**LEED™ Accredited Professional**	1	*None beyond baseline.*	Project architect already accredited.	N/A	N/A

Yes	No		
34	**35**	**Project Totals**	**69** Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

6.2 Category-Level Analysis Summary Sheets and Key Supporting Calculations

6.2.1 McCaw Hall

LEED Credit Category:	**SS - Sustainable Sites**				**McCaw Hall Analysis Summary**
	Totals	**By credits:**	4.2 (bike racks)	4.3 (charging stations)	**Notes**
NET INITIAL COSTS (Quantifiable)		(shaded cell/blue font indicate original spreadsheet inputs)			
Primary	16,100		1,100	15,000	4.2: For 8' rack ,assumed $1,000 plus $100 for installation.
Secondary	-				4.3: Per Seattle Center estimate.
FIRST-YEAR IMPACTS					
Primary					
Electricity	-	kWh/year			
Electric demand	-	kW/month			
Natural gas	-	therms/year			
Water	-	CCF/year			
Sewer	-	CCF/year			
Other primary	-	$/year			
Secondary					
Greenhouse gas	-	$/year			
Productivity	-	$/year			
Other secondary	-	$/year			

		Discount Rate	
QUANTIFIABLE BENEFITS SUMMARY		**2%**	**6%**
Primary	Building energy	$0	$0
	Building water/sewer	$0	$0
	Building other	$0	$0
Secondary	Building work environment	$0	$0
	Building other	$0	$0
	City/utility avoided costs	$0	$0
	Greenhouse gas reduction	$0	$0

LEED Credit Category: **WE - Water Efficiency** **McCaw Hall Analysis Summary**

	Totals	By credits:	WE-1.1,1.2 (Land-scaping)	WE-3.1 (use reduction)	Notes
NET INITIAL COSTS (Quantifiable)		(shaded cell/blue font indicate original spreadsheet inputs)			
Primary	($9,300)		350	(9,650)	
Secondary	$3,950		350	3,600	
FIRST-YEAR IMPACTS					
Primary					
Electricity	-	kWh/year			
Electric demand	-	kW/month			
Natural gas	-	therms/year			
Water	212	CCF/year	25	186	
Sewer	186	CCF/year	-	186	Assume deduct meter in place for WE-1.1,1.2 (no sewer savings).
Other primary	150	$/year		150	Maintenance savings from waterless urinals.
Secondary					
Greenhouse gas	-	$/year			
Productivity	-	$/year			
Other secondary	-	$/year			

		Discount Rate	
QUANTIFIABLE BENEFITS SUMMARY		**2%**	**6%**
Primary	Building energy	$0	$0
	Building water/sewer	$30,915	$20,439
	Building other	$2,987	$2,033
Secondary	Building work environment	$0	$0
	Building other	$0	$0
	City/utility avoided costs	$0	$0
	Greenhouse gas reduction	$0	$0

LEED Credit Category: **EA - Energy & Atmosphere** **McCaw Hall Analysis Summary**

	Totals	By credits:	EA-P1,3 (Cx)	EA-P2,1.1,1.2 (energy eff)	EA-5 (M&V)	Notes
NET INITIAL COSTS (Quantifiable)		(shaded cell/blue font indicate original spreadsheet inputs)				
Primary	$445,966		175,000	240,966	30,000	Assumed that M&V + continuous Cx (below) maintains 100% of Cx, energy
Secondary	$139,525		15,068	124,456	-	efficiency gains over bldg life.
FIRST-YEAR IMPACTS						
Primary						
Electricity	701,353	kWh/year	107,448	593,905	-	
Electric demand	148	kW/month	12	136	-	
Natural gas	15,028	therms/year	2,878	12,149	-	
Water	-	CCF/year				
Sewer	-	CCF/year				
Other primary	-	$/year				
Secondary						
Greenhouse gas	628	$/year		628		<--Values slightly higher for first two years as electric offsets come online.
Productivity	-	$/year				
Other secondary	(5,000)	$/year			(5,000)	<--Add'l continuous Cx labor @ 4 hrs/week 10% FTE, 50,000

QUANTIFIABLE BENEFITS SUMMARY		Discount Rate 2%	6%
Primary	Building energy	$838,984	$584,256
	Building water/sewer	$0	$0
	Building other	$0	$0
Secondary	Building work environment	$0	$0
	Building other	($99,570)	($67,752)
	City/utility avoided costs	$0	$0
	Greenhouse gas reduction	$12,808	$8,809

Baseline electric use	2,733,049	kWh/yr
Combined electric savings	26%	

ECM #	Measure Description	Original Analysis					Adjusted Estimate				
		Savings			Cost	SCL incentive	Savings				Cost
		kWh	kW	Therms	$		kWh	EFLH	kW	Therms	$
1	Internal Operable Lobby Shades	23,695		99	$ 115,330	$ 115,381	23,695	1,000	23.7	99	$ 115,330
2	Variable Speed Pumping	115,139		1,098	$ 33,300		64,800	3,800	17.1	-	$ 33,300
3	Demand Control Ventilation	218,505		6,962	$ 24,000		218,505	8,760	24.9	6,962	$ 24,000
4	VAV Kitchen Exhaust Hood	17,691		1,709	$ 12,386		17,691	8,760	2.0	1,709	$ 12,386
5	Fan Powered VAV Boxes	84,700		7	$ 13,920		84,700	3,800	22.3	7	$ 13,920
6	VAV in Auditoruim	34,399		4,254	$ 24,000		34,399	3,800	9.1	4254	$ 24,000
7	2nd Balcony VAV in Lobby	64,028		(338)	$ 30,787		64,028	3,800	16.8	-338	$ 30,787
8	Delta P Valves	63,882			$ 20,400		31,941	3,800	8.4	-	$ 20,400
1-8	ECM 1-8 design costs				$ 22,386						$ 22,386
A	Theater Work Lighting	42,705			$ 26,553	$ 5,979	32,029	2,738	11.7	(322)	$ 17,913
B	Front of house lighting controls.	N/A		N/A	N/A	$ 3,096	22,117			(222)	$ 33,000
C	DOE-2 Study Costs										$ 18,000
	Totals	664,744		13,791	$ 323,062	**$ 124,456**	**593,905**		**136.0**	**12,149**	**$ 365,422**

ECMs 1-8 estimated by Cdi, ECM A by architect Peter Hamilton Locke.
ECM B costs and savings estimated based on partial preliminary information.
SCL incentives for ECMs 1-8 based on CDi summary sheet provided by S Van Dyke on Sept 2002.
SCL incentives for ECMs A, B based on SCL ESD lighting incentive rate for new fixtures/controls of $0.14/kWh saved.

Lobby lighting, per VisualDOE model

Zone	Area	LPD	kW
Lobby_1	4938	0.72	3.6
Lobby_I	6775	2.98	20.2
Lobby_E	4466	2.99	13.4
Foyer	25271	0.72	18.2
TOTAL	41450	1.33	**55.3**

Estimated hour reduction **400** hours/year

LEED Credit Category: **MR - Materials & Resources** **McCaw Hall Analysis Summary**

	Totals	By credits: ALL		Notes
NET INITIAL COSTS (Quantifiable)		(shaded cell/blue font indicate original spreadsheet inputs)		
Primary	$4,000		4,000	$4k incremental cost for using recycied content for major items.
Secondary	$0		-	No incremental benefits beyond baseline.
FIRST-YEAR IMPACTS				>75% construction waste recycling included under ID credit.
Primary				
Electricity	-	kWh/year	-	
Electric demand	-	kW/month	-	
Natural gas	-	therms/year	-	
Water	-	CCF/year	-	
Sewer	-	CCF/year	-	
Other primary	-	$/year	-	
Secondary				
Greenhouse gas	-	$/year	-	
Productivity	-	$/year	-	
Other secondary	-	$/year	-	

		Discount Rate	
QUANTIFIABLE BENEFITS SUMMARY		**2%**	**6%**
Primary	Building energy	$0	$0
	Building water/sewer	$0	$0
	Building other	$0	$0
Secondary	Building work environment	$0	$0
	Building other	$0	$0
	City/utility avoided costs	$0	$0
	Greenhouse gas reduction	$0	$0

LEED Credit Category: **EQ - Indoor Environmental Quality** **McCaw Hall Analysis Summary SUMMARY**

	Totals	By credits:		Notes		
NET INITIAL COSTS (Quantifiable)		(shaded cell/blue font indicate original spreadsheet inputs)		(add'l calcs on supporting spreadsheet)		
Primary	177,400		**$177,400**	Credit 2	Add'l diffusers	$5,500
Secondary	-			Credit 3.1	Construction IAQ Management Plan	$144,000
				Credit 3.2	Add'l electricity for 2-week flushout + filters	$5,589
FIRST-YEAR IMPACTS				Credit 6.1/6.2	Controllability of Systems	$15,000
Primary				Credit 8.1/8.2	Daylight & Views	$7,250
Electricity	-	kWh/year				
Electric demand	-	kW/month				
Natural gas	-	therms/year				
Water	-	CCF/year				
Sewer	-	CCF/year				
Other primary	-	$/year				
Secondary						
Greenhouse gas	-	$/year				
Productivity	2,331	$/year	2,331	Based on estimates from Paladino's Seattle LEED Project Tracker, adjusted for baseline and 50% conservative factor.		
Other secondary	-	$/year				

		Discount Rate	
QUANTIFIABLE BENEFITS SUMMARY		**2%**	**6%**
Primary	Building energy	$0	$0
	Building water/sewer	$0	$0
	Building other	$0	$0
Secondary	Building work environment	$46,411	$31,580
	Building other	$0	$0
	City/utility avoided costs	$0	$0
	Greenhouse gas reduction	$0	$0

INDIRECT (SECONDARY) IMPACTS

Based on the Seattle LEED Project Tracker, developed by Paladino & Company.

(Shaded areas contain a "1" for each LEED credit that results in action beyond baseline.)

General assumptions		
Est. full-time employees (FTE)	6	FTE
% with allergies	27.9%	
% with asthma	5.2%	
Est. average salary	$54,455	$/year/FTE
Payroll cost	$326,730	/year
Annual work days	312	days/year
Avg. absence days due to:		
Illness	6	days/year/FTE
Allergies	3.3	days/year/FTE
Asthma	3.4	days/year/FTE
Increased comfort control		
Applicable LEED credits		
IEQ 6.1 Controllability of Systems, Perimeter	1	
IEQ 6.2 Controllability of Systems, Non-Perimeter	1	
IEQ 8.1 Daylight & Views, Daylight 75% of Spaces	1	
IEQ 8.2 Daylight & Views, Views for 90% of Spaces	1	
Total credits	4	credits
Productivity increase factor	0.25%	/LEED credit
Equivalent productivity value from related LEED credits	**$3,267**	
Value/credit	$817	/credit
Reduction of communicable respiratory diseases		
Applicable LEED credits		
IEQ 1 Carbon Dioxide (CO_2) Monitoring	1	
IEQ 2 Increase Ventilation Effectiveness	1	
Total credits	2	credits
Absence day reduction factor	11%	/LEED credit
Equivalent productivity value from related LEED credits	**$1,382**	
Value/credit	$691	/credit
Control of toxins & irritants		
Applicable LEED credits		
IEQ p2 Environmental Tobacco Smoke (ETS) Control		
IEQ 3.1 Construction IAQ Management Plan, During Construction	1	
IEQ 3.2 Construction IAQ Management Plan, Before Occupancy	1	
IEQ 4.1 Low-Emitting Materials, Adhesives & Sealants		
IEQ 4.2 Low-Emitting Materials, Paints		
IEQ 4.3 Low-Emitting Materials, Carpet		
IEQ 4.4 Low-Emitting Materials, Composite Wood		
IEQ 5 Indoor Chemical & Pollutant Source Control		
IEQ 7.2 Thermal Comfort, Permanent Monitoring System		
Total credits	2	credits
Employees with allergies	2	FTE
Lost productivity	$964	
Lost productivity (with measures)	$955	
Employees with asthma	0	FTE
Lost productivity	$185	
Lost productivity (with measures)	$183	
Equivalent productivity value from related LEED credits	**$11**	
Value/credit	$6	/credit
Gross equivalent productivity value	$4,661	
Conservative adjustment for methodological uncertainty (% of gross)	50%	
Net equivalent productivity value	**$2,331**	

LEED Credit Category:	ID - Innovation & Design Process							McCaw Hall Analysis Summary
	Totals	**By credits:**	ID-1.1 (salvage)	ID-1.2 (LEED education)	ID-1.3 (theatrical lites)	ID-1.4 (90% construc recycle)	ID-2 (LEED pro)	**Notes**
NET INITIAL COSTS (Quantifiable)		(shaded cell/blue font indicate original spreadsheet inputs)						1.1 : Rough estimate of avoided disposal fees from salvage.
Primary	$115,000		(5,000)	-	-	120,000	-	1.2: Cost of LEED education program assumed negligible.
Secondary	$0		-	-	-	-	-	1.3: Cost/savings from theatrical lights included in EA credits.
								1.4: Because contractor bids include disposal cost, assumed that construction recycling yielded no avoided disposal cost benefits to the owner.
FIRST-YEAR IMPACTS								
Primary								1.5: Cost of LEED accredited professional assumed negligible.
Electricity	-	kWh/year	-	-	-	-	-	
Electric demand	-	kW/month	-	-	-	-	-	
Natural gas	-	therms/year	-	-	-	-	-	
Water	-	CCF/year	-	-	-	-	-	
Sewer	-	CCF/year	-	-	-	-	-	
Other primary	-	$/year	-	-	-	-	-	
Secondary								
Greenhouse gas	2,159	$/year	-	-	-	2,159	-	First-year impact only from avoided landfill impacts.
Productivity	-	$/year	-	-	-	-	-	
Other secondary	-	$/year	-	-	-	-	-	

		Discount Rate	
QUANTIFIABLE BENEFITS SUMMARY		**2%**	**6%**
Primary	Building energy	$0	$0
	Building water/sewer	$0	$0
	Building other	$0	$0
Secondary	Building work environment	$0	$0
	Building other	$0	$0
	City/utility avoided costs	$0	$0
	Greenhouse gas reduction	$2,159	$2,159

6.2.2 Justice Center

LEED Credit Category:	SS - Sustainable Sites					Justice Center Analysis Summary
	Totals	By credits:	4.3 Refueling stations	5.1, 6.1, 7.2 Green Roof	6.1 Stormwater retention	Notes
NET INITIAL COSTS (Quantifiable)		(shaded cell/blue font indicate original spreadsheet inputs)				
Primary	$63,996		14,100	46,355	3,541	Costs for rainwater collection system beyond water tank included under Credit SS-6.1 included in WE-1.1,1.2
Secondary	$0					Energy impacts of Green/white membrane roof assumed negligible.
FIRST-YEAR IMPACTS						
Primary						
Electricity	-	kWh/year				
Electric demand	-	kW/month				
Natural gas	-	therms/year				
Water	-	CCF/year				
Sewer	-	CCF/year				
Other primary	-	$/year		-		<-- Assumed no reduction in SPU stormwater charges.
Secondary						
Greenhouse gas	-	$/year				
Productivity	-	$/year				
Other secondary	-	$/year				

QUANTIFIABLE BENEFITS SUMMARY		Discount Rate 2%	6%
Primary	Building energy	$0	$0
	Building water/sewer	$0	$0
	Building other	$0	$0
Secondary	Building work environment	$0	$0
	Building other	$0	$0
	City/utility avoided costs	$0	$0
	Greenhouse gas reduction	$0	$0

LEED Credit Category: **WE - Water Efficiency** **Justice Center Analysis Summary**

	Totals	By credits:	WE-1.1,1.2 (Land-scaping)	Notes
NET INITIAL COSTS (Quantifiable)		(shaded cell/blue font indicate original spreadsheet inputs)		
Primary	$750		750	
Secondary	$750		750	
FIRST-YEAR IMPACTS				
Primary				
Electricity	-	kWh/year		
Electric demand	-	kW/month		
Natural gas	-	therms/year		
Water	10	CCF/year	10	
Sewer	-	CCF/year	-	Assumed deduct meter in place, so no sewer charge savings.
Other primary	-	$/year		
Secondary				
Greenhouse gas	-	$/year		
Productivity	-	$/year		
Other secondary	-	$/year		

QUANTIFIABLE BENEFITS SUMMARY		Discount Rate 2%	6%
Primary	Building energy	$0	$0
	Building water/sewer	$399	$264
	Building other	$0	$0
Secondary	Building work environment	$0	$0
	Building other	$0	$0
	City/utility avoided costs	$0	$0
	Greenhouse gas reduction	$0	$0

LEED Credit Category: **EA - Energy & Atmosphere** **Justice Center Analysis Summary**

	Totals	By credits:	EA-P1,3 (Cx)	EA-P2,1.1,1.2 (energy eff)	EA-5 (M&V)	Notes
NET INITIAL COSTS (Quantifiable)		(shaded cell/blue font indicate original spreadsheet inputs)				
Primary	$559,393		178,000	381,393	-	Assumed that M&V + continuous Cx (below) maintains 100% of Cx, energy
Secondary	$400,018		15,151	384,867	-	efficiency gains over bldg life.
FIRST-YEAR IMPACTS						Portion of buffer wall (ECM-18) costs included in IR credits.
Primary						Staircase (ECM-20) cost not included, since not due to LEED.
Electricity	1,675,454	kWh/year	336,000	1,339,454	-	M&V costs already included in Cx budget.
Electric demand	359	kW/month	67	292	-	
Natural gas	(3,617)	therms/year	9,000	(12,617)	-	
Water	-	CCF/year	-	-	-	
Sewer	-	CCF/year	-	-	-	
Other primary	(5,000)	$/year	-	-	(5,000)	<--Add'l continuous Cx labor @ 4 hrs/wee 10% FTE, 50,000 $/year
Secondary						
Greenhouse gas	(151)	$/year	-	(151)	-	<--Values positive for Year 1, less negative for Year 2 as electric offsets come online.
Productivity	-	$/year	-	-	-	
Other secondary	-	$/year	-	-	-	

		Discount Rate 2%	Discount Rate 6%
QUANTIFIABLE BENEFITS SUMMARY			
Primary	Building energy	$1,556,198	$1,092,503
	Building water/sewer	$0	$0
	Building other	($99,570)	($67,752)
Secondary	Building work environment	$0	$0
	Building other	$0	$0
	City/utility avoided costs	$0	$0
	Greenhouse gas reduction	($2,278)	($1,325)

Baseline electric use	8,546,534	kWh/yr
Combined electric savings	20%	

ECM #	Measure Description	CDI Analysis Savings kWh	kW	Therms	Cost $	SCL incentive	Adjusted Estimate Savings kWh	Dmd hours	kW	Therms	Cost $	SCL incentive (prorated)
1	Efficient Chiller	265,248	294.7	na	$ 308,500		132,624	1,200	110.5		**$ 69,231**	$ -
2	Lighting Fixtures	345,635	103.0	nc	$ 1,254,319		345,635	6,500	53.2	(3,470)	**$ 209,053**	$ -
3	Occupancy Sensors	222,605	na	nc	$ 75,518		222,605	8,760	25.4	(2,235)	$ 75,518	$ -
4	LED Exit Signs	29,256	3.3	nc	$ 43,409		29,256	8,760	3.3	(294)	$ 10,000	$ -
5	Variable flow CWS&R	989,650		-	$ 67,000		79,098	8,760	9.0		$ 67,000	$ -
6	Variable flow HWS&R	252,109		-	$ 24,500		70,473	8,760	8.0		$ 24,500	$ -
7	Delta P Valves	87,610			$ 3,600		59,473	8,760	6.8		$ 3,600	$ -
8	Fan Powered VAV Boxes	240,511		(3,895)	$ 134,680		240,511	8,760	27.5	(3,895)	$ 134,680	$ -
9	Building Envelope Upgrade											
10	Carbon Monoxide Sensors	4,713		-	$ 5,000		4,713	4,000	1.2		$ 5,000	$ -
11	Carbon Dioxide Sensors	34,053		(1,822)	$ 42,200		34,053	8,760	3.9	(1,822)	$ 42,200	$ -
12	Condensing Water Controls	29,645			$ 9,700		14,823	1,200	12.4		$ 9,700	$ -
13	Cooling Tower VFD	13,784			$ 24,000		6,892	1,200	5.7		$ 24,000	$ -
14	not used											
15	Timer Switches	34,131			$ 4,300		34,131	3,800	9.0	(343)	$ 4,300	$ -
16	Daylighting Controls	55,765			$ 7,978		55,765	3,800	14.7	(560)	$ 7,978	$ -
17	Water Loop Heat Pumps	9,402			$ 61,500		9,402	8,760	1.1		$ 61,500	$ -
18	Thermal Buffer	49,047			$ 1,000,000		-	8,760	-		**$ -**	$ -
19	AHU Zoning	48,818			$ 300,000		0				$ -	$ -
20	Elevator Use	269,992			$ 725,000		-	3,800	-		**$ -**	$ -
A	DOE-2 Study Costs										$ 18,000	
	Totals	2,981,974		(5,717)	$ 4,091,204	**$ 384,867**	**1,339,454**		**291.7**	(12,617)	**$ 766,260**	$ -

ECM-1: Efficient Chiller - Revised Estimates of Incremental Costs

Per CDi:

Chiller material cost	$	300,000
Chiller installation cost	$	8,500
Assumed efficient chiller mat'l cost more by		30%
Revised incremental measure cost	**$**	**69,231**

ECM-2: Lighting Fixtures - Revised Estimates of Incremental Costs

Assumed % cost increase due to efficient lighting		20%
Revised base cost	$	1,045,266
Reestimated incremental measure cost	**$**	**209,053**

Bing Tso:
Per John Roberts (SCL) e-mail of 12/20/02.

LEED Credit Category: **MR - Materials & Resources** **Justice Center Analysis Summary**

	Totals	By credits: ALL		Notes
NET INITIAL COSTS (Quantifiable)		(shaded cell/blue font indicate original spreadsheet inputs)		
Primary	$0		-	No costs or benefits beyond baseline.
Secondary	$0		-	
FIRST-YEAR IMPACTS				
Primary				
Electricity	-	kWh/year	-	
Electric demand	-	kW/month	-	
Natural gas	-	therms/year	-	
Water	-	CCF/year	-	
Sewer	-	CCF/year	-	
Other primary	-	$/year	-	
Secondary				
Greenhouse gas	-	$/year	-	
Productivity	-	$/year	-	
Other secondary	-	$/year	-	

		Discount Rate	
QUANTIFIABLE BENEFITS SUMMARY		**2%**	**6%**
Primary	Building energy	$0	$0
	Building water/sewer	$0	$0
	Building other	$0	$0
Secondary	Building work environment	$0	$0
	Building other	$0	$0
	City/utility avoided costs	$0	$0
	Greenhouse gas reduction	$0	$0

LEED Credit Category: **EQ - Indoor Environmental Quality** **Justice Center Analysis Summary**

	Totals	By credits:	EQ-3.2 - OA flush, filters	EQ-8.1 - Light shelf	Notes
NET INITIAL COSTS (Quantifiable)		(shaded cell/blue font indicate original spreadsheet inputs)			
Primary	$186,406		10,906	175,500	EQ-1: CO2 monitoring cost included under EA1.1/2.
Secondary	$0				EQ-2: Assume city chooses not to perform ASHRAE 129-1997 test.
FIRST-YEAR IMPACTS					Portion of light shelf cost assigned to LEED = 75%
Primary					Buffer wall cost included under ID-1.1.
Electricity	-	kWh/year			
Electric demand	-	kW/month			
Natural gas	-	therms/year			
Water	-	CCF/year			
Sewer	-	CCF/year			
Other primary	-	$/year			
Secondary					
Greenhouse gas	-	$/year			
Productivity	113,150	$/year	113,150		Based on estimates from Paladino's Seattle LEED Project Tracker.
Other secondary	-	$/year			

QUANTIFIABLE BENEFITS SUMMARY		Discount Rate 2%	6%
Primary	Building energy	$0	$0
	Building water/sewer	$0	$0
	Building other	$0	$0
Secondary	Building work environment	$2,253,270	$1,533,230
	Building other	$0	$0
	City/utility avoided costs	$0	$0
	Greenhouse gas reduction	$0	$0

INDIRECT (SECONDARY) IMPACTS

Based on the Seattle LEED Project Tracker, developed by Paladino & Company.

(Shaded areas contain a "1" for each LEED credit that results in action beyond baseline.)

General assumptions		
Est. full-time employees (FTE)	800	FTE
% with allergies	27.9%	
% with asthma	5.2%	
Est. average salary	$54,455	$/year/FTE
Payroll cost	$43,564,000	/year
Annual work days	249	days/year
Avg. absence days due to:		
Illness	6	days/year/FTE
Allergies	3.3	days/year/FTE
Asthma	3.4	days/year/FTE
Increased comfort control		
Applicable LEED credits		
IEQ 6.1 Controllability of Systems, Perimeter		
IEQ 6.2 Controllability of Systems, Non-Perimeter		
IEQ 8.1 Daylight & Views, Daylight 75% of Spaces	1	
IEQ 8.2 Daylight & Views, Views for 90% of Spaces		
Total credits	1	credits
Productivity increase factor	0.25%	/LEED credit
Equivalent productivity value from related LEED credits	**$108,910**	
Value/credit	$26,138	/credit
Reduction of communicable respiratory diseases		
Applicable LEED credits		
IEQ 1 Carbon Dioxide (CO2) Monitoring	1	
IEQ 2 Increase Ventilation Effectiveness		
Total credits	1	credits
Absence day reduction factor	11%	/LEED credit
Equivalent productivity value from related LEED credits	**$115,471**	
Value/credit	$27,713	/credit
Control of toxins & irritants		
Applicable LEED credits		
IEQ p2 Environmental Tobacco Smoke (ETS) Control		
IEQ 3.1 Construction IAQ Management Plan, During Construction		
IEQ 3.2 Construction IAQ Management Plan, Before Occupancy	1	
IEQ 4.1 Low-Emitting Materials, Adhesives & Sealants		
IEQ 4.2 Low-Emitting Materials, Paints		
IEQ 4.3 Low-Emitting Materials, Carpet		
IEQ 4.4 Low-Emitting Materials, Composite Wood		
IEQ 5 Indoor Chemical & Pollutant Source Control		
IEQ 7.2 Thermal Comfort, Permanent Monitoring System	1	
Total credits	2	credits
Employees with allergies	223	FTE
Lost productivity	$161,082	
Lost productivity (with measures)	$159,471	
Employees with asthma	42	FTE
Lost productivity	$30,932	
Lost productivity (with measures)	$30,623	
Equivalent productivity value from related LEED credits	**$1,920**	
Value/credit	$230	/credit
Gross equivalent productivity value	$226,301	
Conservative adjustment for methodological uncertainty (% of gross)	50%	
Net equivalent productivity value	**$113,150**	

redit Category: **ID - Innovation & Design Process** **Justice Center Analysis Summary**

	Totals	By credits:	ID-1.1 Buffer wall		Notes	
TIAL COSTS (Quantifiable)		(shaded cell/blue font indicate original spreadsheet inputs)				
	500,000		500,000	-	Total cost of buffer wall	$1,000,000
ry	-		-	-	% attributed to LEED (assumption)	50%
EAR IMPACTS					**Net incremental cost**	**$500,000**
ectricity	-	kWh/year	-	-		
ectric demand	-	kW/month	-	-		
atural gas	-	therms/year	-	-		
ater	-	CCF/year	-	-		
ewer	-	CCF/year	-	-		
ther primary	-	$/year	-	-		
ary						
reenhouse gas	-	$/year	-	-		
oductivity	-	$/year	-	-		
ther secondary	-	$/year	-	-		

		Discount Rate 2%	6%
FIABLE BENEFITS SUMMARY			
	Building energy	$0	$0
	Building water/sewer	$0	$0
	Building other	$0	$0
ary	Building work environment	$0	$0
	Building other	$0	$0
	City/utility avoided costs	$0	$0
	Greenhouse gas reduction	$0	$0

6.3 General Economic Assumptions

Years of Analysis	25	Per Seattle Office of Sustainability & Environment (SOSE) stipulations.
Discount rates (real)		
Scenario 1	2.0%	Per SOSE stipulations.
Scenario 2	6.0%	Per SOSE stipulations.
General inflation rate	2.8%	From official U.S. federal government figures for 2001.

	Utility	Billing rates		Billing Rate Source	Annual rate escalation	Escalation Source
1	Electricity	$ 0.0586	/kWh	From Seattle City Light Medium Standard General Service rate, effective 6/14/02.	-6.0% (nominal, until 2005) 1.0% (nominal, 2005 and beyond) -8.8% (real, until 2005) -1.8% (real, 2005-2021)	Per SOSE stipulations. Per SOSE stipulations. = nominal escalation - general inflation rate. = nominal escalation - general inflation rate.
2	Electric demand	$ 1.03	/kW/month	From Seattle City Light Medium Standard General Service rate, effective 6/14/02.	--	Assumed same as for electricity rates.
3	Natural gas	$ 0.55338	/therm	From Puget Sound Energy summary of total current prices for Schedule 31 (Commercial & Industrial General Service), effective 11/01/02.	0.3% (real)	Per USDOE FEMP Energy Price Indices & Discount Factors for Life-Cycle Cost Analysis - April 2002, Table Cb-4, Years 2002-2027 (averaged).
4	Water (off-peak 9/16-5/15)	$ 1.69	/CCF	From Seattle Public Utilities staff.	1.5% (real)	Per SOSE stipulations.
	Water (peak 5/15-9/16)	$ 2.75	/CCF			
5	Sewer	$ 5.12	/CCF	Per Seattle Public Utilities 2001-2002 wastewater rates on Web. Adjusted downward by $0.0675/CCF to account for lost city tax revenues from reduction.	1.5% (real)	Per SOSE stipulations.

6.4 Project Analysis Summary Sheets

BENEFIT-COST ANALYSIS
LEED Silver Certification for the Marion Oliver McCaw Performance Hall

All numbers below are 25-year life cycle impacts, expressed in net present value dollars (NPV$).

	Level	LEED Credit Category SS Sustainable Sites	WE Water Efficiency	EA Energy & Atmosphere	MR Materials & Resources	EQ Indoor Environmental Quality	ID Innovation & Design Process	TOTALS
INITIAL NET COSTS								
Primary*	Building	18,900	(6,500)	448,700	6,800	180,200	117,800	765,900
Secondary	City	-	4,000	139,500	-	-	-	143,500
SUSTAINED NET SAVINGS - 2% discount rate								
Primary								
Energy	Building	-	-	839,000	-	-	-	839,000
Water/sewer	Building	-	30,900	-	-	-	-	30,900
Other	Building	-	3,000	-	-	-	-	3,000
Secondary								
Productivity	Building	-	-	-	-	46,400	-	46,400
Other	Building	-	-	(99,600)	-	-	-	(99,600)
Avoided costs	City	-	-	-	-	-	-	-
Greenhouse gas reduction	City	-	-	12,800	-	-	2,200	15,000
SUSTAINED NET SAVINGS - 6% discount rate								
Primary								
Energy	Building	-	-	584,300	-	-	-	584,300
Water/sewer	Building	-	20,400	-	-	-	-	20,400
Other	Building	-	2,000	-	-	-	-	2,000
Secondary								
Productivity	Building	-	-	-	-	31,600	-	31,600
Other	Building	-	-	(67,752)	-	-	-	(67,752)
Avoided costs	City	-	-	-	-	-	-	-
Greenhouse gas reduction	City	-	-	8,800	-	-	2,200	11,000
BENEFIT COST RATIOS								
COSTS								
Primary / Building		18,900	(6,500)	448,700	6,800	180,200	117,800	765,900
Secondary / City		-	4,000	139,500	-	-	-	143,500
TOTAL		**18,900**	**(2,500)**	**588,200**	**6,800**	**180,200**	**117,800**	**909,400**
% of Total		**2%**	**0%**	**65%**	**1%**	**20%**	**13%**	**100%**
BENEFITS								
@ 2% discount rate								
Primary		-	33,900	839,000	-	-	-	872,900
Secondary		-	-	(86,800)	-	46,400	2,200	(38,200)
Building		-	33,900	739,400	-	46,400	-	819,700
City		-	-	12,800	-	-	2,200	15,000
TOTAL		**-**	**33,900**	**752,200**	**-**	**46,400**	**2,200**	**834,700**
% of Total		**0%**	**4%**	**90%**	**0%**	**6%**	**0%**	**100%**
@ 6% discount rate								
Primary		-	22,400	584,300	-	-	-	606,700
Secondary		-	-	(58,952)	-	31,600	2,200	(25,152)
Building		-	22,400	516,548	-	31,600	-	570,548
City		-	-	8,800	-	-	2,200	11,000
TOTAL		**-**	**22,400**	**525,348**	**-**	**31,600**	**2,200**	**581,548**
% of Total		**0%**	**4%**	**90%**	**0%**	**5%**	**0%**	**100%**
RATIOS								
@ 2% discount rate								
Primary impacts only		-	--	1.87	-	-	-	1.14
Building impacts only		-	--	1.65	-	0.26	-	1.07
Including all impacts		**-**	**--**	**1.28**	**-**	**0.26**	**0.02**	**0.92**
@ 6% discount rate								
Primary impacts only		-	--	1.30	-	-	-	0.79
Building impacts only		-	--	1.15	-	0.18	-	0.74
Including all impacts		**-**	**--**	**0.89**	**-**	**0.18**	**0.02**	**0.64**

* Includes LEED Administration Costs (divided equally among all credit categories)

Registration fee (USGBC member)	$350	
Certification fee (USGBC member)	$1,200	
Application preparation	$15,000	Low end of Paladino & Associate estimates ($10K+ for experienced team/early start; <$60K for inexperienced team/late start)
TOTAL	$16,550	

BENEFIT-COST ANALYSIS
LEED Silver Certification for the Seattle Justice Center

All numbers below are 25-year life cycle impacts, expressed in net present value dollars (NPV$).

	Level	LEED Credit Category SS Sustainable Sites	WE Water Efficiency	EA Energy & Atmosphere	MR Materials & Resources	EQ Indoor Environmental Quality	ID Innovation & Design Process	TOTALS
INITIAL NET COSTS								
Primary*	Building	66,800	3,500	562,200	2,800	189,200	502,800	1,327,300
Secondary	City	-	800	400,000	-	-	-	400,800
SUSTAINED NET SAVINGS - 2% discount rate								
Primary								
Energy	Building	-	-	1,556,200	-	-	-	1,556,200
Water/sewer	Building	-	400	-	-	-	-	400
Other	Building	-	-	(99,600)	-	-	-	(99,600)
Secondary								
Productivity	Building	-	-	-	-	2,253,300	-	2,253,300
Other	Building	-	-	-	-	-	-	-
Avoided costs	City	-	-	-	-	-	-	-
Greenhouse gas reduction	City	-	-	(2,300)	-	-	-	(2,300)
SUSTAINED NET SAVINGS - 6% discount rate								
Primary								
Energy	Building	-	-	1,092,500	-	-	-	1,092,500
Water/sewer	Building	-	300	-	-	-	-	300
Other	Building	-	-	(67,800)	-	-	-	(67,800)
Secondary								
Productivity	Building	-	-	-	-	1,533,200	-	1,533,200
Other	Building	-	-	-	-	-	-	-
Avoided costs	City	-	-	-	-	-	-	-
Greenhouse gas reduction	City	-	-	(1,300)	-	-	-	(1,300)
BENEFIT COST RATIOS								
COSTS								
Primary / Building		66,800	3,500	562,200	2,800	189,200	502,800	1,327,300
Secondary / City		-	800	400,000	-	-	-	400,800
TOTAL		**66,800**	**4,300**	**962,200**	**2,800**	**189,200**	**502,800**	**1,728,100**
% of Total		**4%**	**0%**	**56%**	**0%**	**11%**	**29%**	**100%**
BENEFITS								
@ 2% discount rate								
Primary		-	400	1,456,600	-	-	-	1,457,000
Secondary		-	-	(2,300)	-	2,253,300	-	2,251,000
Building		-	400	1,456,600	-	2,253,300	-	3,710,300
City		-	-	(2,300)	-	-	-	(2,300)
TOTAL		**-**	**400**	**1,454,300**	**-**	**2,253,300**	**-**	**3,708,000**
% of Total		**0%**	**0%**	**39%**	**0%**	**61%**	**0%**	**100%**
@ 6% discount rate								
Primary		-	300	1,024,700	-	-	-	1,025,000
Secondary		-	-	(1,300)	-	1,533,200	-	1,531,900
Building		-	300	1,024,700	-	1,533,200	-	2,558,200
City		-	-	(1,300)	-	-	-	(1,300)
TOTAL		**-**	**300**	**1,023,400**	**-**	**1,533,200**	**-**	**2,556,900**
% of Total		**0%**	**0%**	**40%**	**0%**	**60%**	**0%**	**100%**
RATIOS								
@ 2% discount rate								
Primary impacts only		-	0.11	2.59	-	-	-	1.10
Building impacts only		-	0.11	2.59	-	11.91	-	2.80
Including all impacts		**-**	**0.09**	**1.51**	**-**	**11.91**	**-**	**2.15**
@ 6% discount rate								
Primary impacts only		-	0.09	1.82	-	-	-	0.77
Building impacts only		-	0.09	1.82	-	8.10	-	1.93
Including all impacts		**-**	**0.07**	**1.06**	**-**	**8.10**	**-**	**1.48**

* Includes LEED Administration Costs (divided equally among all credit categories)

Registration fee (USGBC member)	$350	
Certification fee (USGBC member)	$1,200	
Application preparation	$15,000	Low end of Paladino & Associate estimates ($10K+ for experienced team/early start; <$60K for inexperienced team/late start)
TOTAL	$16,550	